NAVY
SBIR FY04.2 PROPOSAL SUBMISSION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **3 May 2004.** For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I PROPOSAL SUBMISSION:

Read the DoD Program Solicitation at www.dodsbir.net/solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I option should address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I proposals, including the option, have a 25-page limit (see section 3.3). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in section 4.0 of the program solicitation. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

ALL PROPOSAL SUBMISSIONS TO THE NAVY SBIR PROGRAM MUST BE SUBMITTED ELECTRONICALLY

It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR website at **http://www.dodsbir.net/submission**. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the **6:00 a.m. EST, 17 June 2004** deadline. A hardcopy will NOT be required. A signature by hand or electronically is not required when you submit your proposal over the Internet.

Acceptable Formats for Online Submission: All technical proposal files will be converted to Portable Document Format (PDF) for evaluation purposes – do not lock/protect your pdf file. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets. You are required to include your company name, proposal number and topic number as a header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the form available through the Submission website. Technical Proposals should conform to the limitations on margins and number of pages specified in the the DoD Program Solicitation. However, your on-line Cost Proposal will only count as one page and your Cover Sheets will only count as two, no matter how they print out after being converted. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each file you upload. If a virus is detected, the file will be deleted. To verify that your proposal has been received, click on the “Check Upload” icon to view your proposal. Typically, your proposal will be virus checked and converted within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

PHASE I ELECTRONIC FINAL REPORT:

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I contract. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR website at: **http://www.onr.navy.mil/sbir**, click on “Submission”, then click on “Submit a Phase I or II Summary Report”.

ADDITIONAL NOTES:

The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company’s Commercialization Report and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program office noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officer’s Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 1 of this Introduction. The information required by the Navy, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the Navy Activity point of contact (POC) measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal by that Activity’s proper point of contact, listed in Table 1. During or at the end of the Phase I effort awardees will be notified to participate for evaluation of their proposal for a Phase II award. Evaluation criteria for the invitation will be based on the success to which the company has accomplished for the particular topic as evaluated by the monitoring activity/command. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 1. The Navy will also offer a "Fast Track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of the program solicitation). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR project; 2) A 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. **Each of the Navy Activities have different award amounts and schedules; you are required to visit the website cited in the invitation letter to get specific guidance for that Navy Activity before submitting your Phase II proposal.** Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline.

All Phase II award winners must attend a one-day Transition Assistance Program (TAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit http://www.dawnbreaker.com/navytap/index.ph. Recommend budgeting at least one trip to Washington in your Phase II cost proposal.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefit. It should require minimal work from the contractor because most of this information is required in the final report.

Effective in Fiscal Year 2000, a Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

PHASE II ENHANCEMENT

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds for $1,000,000 match of acquisition program funding, can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The governments prime contractors and/or their subcontractors will follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect data rights of the SBIR company.

TABLE 1. NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS

Topic Numbers	Point of Contact	Activity	Phone
N04-153 thru N04-155	Mr. James Johnson	MARCOR	703-432-3327
N04-156	Mrs. Carol Van Wyk	NAVAIR	301-342-0215
N04-157 thru N04-171	Ms. Janet Jaensch	NAVSEA	202-781-3728
N04-172 thru N04-175	Mr. Ron Vermillion	ONR2	540-653-8906
N04-176 thru N04-180	Ms. Cathy Nodgaard	ONR	703-696-0289
N04-181 thru N04-182	Ms. Linda Whittington	SPAWAR	858-537-0146

For general program and administrative questions, please contact the Program Managers above; do not contact them for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 1 March until 3 May 2004. These topic authors are listed on the Navy website under "Solicitation" or the DoD website.   Beginning 3 May, you must use the SITIS system listed in section 1.5c of the program solicitation to receive answers to technical questions

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Make sure you have added a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Your technical proposal has been uploaded. The DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 17 June 2004.

____3. After uploading your file and it is saved on the DoD submission site as a PDF file, review it to ensure that it appears correctly.

____4. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy 04.2 Topic Index

N04-153	Low Cost Titanium Casting Process and Design for Net Shape Components for the Expeditionary Fighting Vehicle (EFV)
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N04-159	Automated Generation and Control of Robust, Real-Time Simulation Environments
N04-160	Synthetic Lubricating & Hydraulic Oil for Motion Control, Steam Turbines and Gears, Military Symbol 2190-TEP Replacement
N04-161	Simulation Environment for Complex, Man-in-the-Loop, Real-Time Systems
N04-162	High Power Limiters based on Silicon Carbide (SiC), and Gallium Nitride (GaN) Device Technology for Phased Array Radar (L,S and X-Band), Communications and EW Applications
N04-163	Active Radar System Thermal Management
N04-164	Electronic Warfare (EW) System Direction Finding (DF) Interference Suppression
N04-165	AN/SLQ-32 IFM/CFR upgrade
N04-166	Fiber Optic/Electrical Lightweight Tow Cable for Optical Towed Arrays
N04-167	Virtual RF Tactical Communications
N04-168	Reactive Tungsten Alloy For Inert Warheads
N04-169	Pellet Dispense & Dispersion Mechanism For Inert Kinetic Energy Munitions
N04-170	Glint Reduction in Staring Focal Plane Array Mid-Wave Thermal Imagers Employing Microscanning
N04-171	Panoramically Scanned TV/FLIR Imaging Sensor with Target Motion Cueing
N04-172	Single-Point Turning Point of Polycrystalline Alumina Missile Domes
N04-173	Polycrystalline Alumina Ogive Infrared Missile Domes
N04-174	EF-18 Electronic Combat Automation
N04-175	Acoustic Surveillance Multi-Array Search Aid
N04-176	Extended Range Optical Underwater Imaging
N04-177	Development of large bulk Silicon Carbide substrates from halogenated precursors
N04-178	Image-Based Obstacle Avoidance
N04-179	Radio Frequency Identification (RFID) Technology Cost Reduction
N04-180	Nested Radio Frequency Identification (RFID) Tags to Improve Supply Chain Management
N04-181	Microminiature Sensor System for FORCENet
N04-182	IP Performance Enhancement Devices

Navy 04.2 Topic Descriptions

N04-153 TITLE: Low Cost Titanium Casting Process and Design for Net Shape Components for the Expeditionary Fighting Vehicle (EFV)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Expeditionary Fighting Vehicle (EFV)

OBJECTIVE: Develop a low cost casting approach for producing titanium structural castings for combat vehicle components. The approach selected should be cost effective over current methods. The process should also be capable of producing near net shape components, with structural integrity and required properties.

DESCRIPTION: The Marine Corps Expeditionary Fighting Vehicle (EFV) is a 76,000-pound armored vehicle designed to operate over harsh off-road terrain and in oceans and rivers. The EFV is expected to operate in severe environments such as high humidity, seawater, sand, mud, rocks, gravel, etc. and must be capable of withstanding severe impact and abrasion loads from rock and debris while moving at high speed (45 mph) over rough cross country terrain. Climatic conditions can range from –65°F to +125°F. In the water mode, EFV operates in seawater at high speeds and over considerable distance.

One of the major objectives of the EFV Program is in controlling the vehicle cost. The EFV uses a significant amount of titanium, which contributes to increased cost for the material and processing, specifically machining. This has to be minimized by using near net shape components, as is possible, by the use of castings. Utilizing a low cost casting process to produce net or near net shape titanium castings, it is expected that overall vehicle costs can be reduced. Use of castings would help avoid or minimize extensive machining that is necessary in the case of titanium forging. Current methods for titanium casting range from investment casting to Ram Graphite Casting, based on quality and cost. In the current project, the objective would be to use an innovative development approach to combine the quality of investment casting and Ram Graphite Casting cost to achieve improved quality and further reduced cost. The casting approach and the alloy considered should provide excellent casting quality, material properties based on high strength and toughness, impact resistance, and good corrosion fatigue and stress corrosion cracking resistance in salt water, and lower cost. Typical minimum properties should equal or exceed the MIL-HDBK-5G 'S' basis values for Ti-6-4 die forgings, and a valid database should be available or developed. Several factors that affect the casting quality need to be addressed. These include cooling rates, grain size and distribution, casting defects, weld repair, and hot isostatic pressing (hipping). There are several potential candidates for low cost casting approach. The primary components to be considered for the low cost casting approach are the Idler Wheel and Sprocket Carrier. Another possible candidate is the Coupling Manifold, a more critical component regarding performance requirements, complex geometry, tolerance requirements, material properties and quality. Based on the success of the project, there is potential for consideration of several other components for the casting approach.

Proposals for this topic should evaluate and develop potential lower-cost methods of producing titanium structural castings, without any penalty in performance or property requirements, quality or cost, compared to their current product forms. The castings should be analyzed for mechanical properties, surface finish, geometrical complexity, dimensional tolerance capability, and cost. In order to prove the structural integrity of the casting, the effects of metal solidification on the microstructure and properties should be studied.

PHASE I: Develop potential lower cost methods for producing titanium structural castings. Identify the casting approach/approaches best suited to meet the objectives, cost and property requirements. Cost, producibility for complex and simple geometry and size, properties of castings, need for Hipping, quality, methods of inspection, and other attributes that could define and distinguish the different approaches, should be analyzed and investigated. Non destructive Test procedures for quality inspection, such as for porosity, inclusions, and other weld defects should be selected and evaluated. Test plans should be developed for insuring the production of sound structural castings and the required database. The materials and processes selected must comply with environmental regulations and requirements and must avoid EFV Program mandated hazardous materials.

Prepare and carry out casting trials from the selected approach and prepare suitable coupons or test components. The efforts should lead to a controlled process that could be used for the casting of EFV components in Phase II, based on the success of the results. Conduct material property and microstructure testing of the castings at the coupon or sub component level, as agreed upon.

PHASE II: Based on the Phase I casting process and test results, optimize the development of the casting process to insure structural integrity has been achieved. Prepare and carry out casting trials of EFV Idler Wheel and Sprocket Carrier. Coordinate with DRPM AAA and the EFV Prime Contractor for the design details and drawings of the two components, Idler Wheel and Sprocket Carrier. Conduct material property and microstructure testing of the cast components and coupons as agreed upon. Based on the success of the casting trials, produce a sufficient number of Idler Wheel and Sprocket Carrier castings. These castings will be used to carry out detailed testing to generate a property database, study the effects of weld repair, hipping, evaluate surface quality and finish, dimensional tolerance capability, and methods of inspection necessary to produce structural castings. The testing will include tensile, fatigue, hardness, fracture toughness, impact, and corrosion (corrosion fatigue, stress corrosion, and dissimilar metal) testing. Other requirements that are agreed upon, such as ballistic tests, will be carried out.

PHASE III: Based on the Phase II results, make further modifications as necessary to the castings as required for the Idler Wheel, the Sprocket Carrier, and the Coupling Manifold, and produce additional sets of components, as agreed upon. Demonstrate producibility of the components and develop a transition and implementation plan into EFV Low Rate Initial Production and production, including the appropriate vendors to produce components for production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lower cost titanium castings will have significant immediate impact on commercial aircraft, farm equipment and machinery industry. These castings will also have widespread use in other commercial industries that use titanium castings.

REFERENCES:
1. Advanced Amphibious Assault Website ¡V www.efv.usmc.mil
2. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22
3. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189
4. MIL-HDBK-5G, Chapter 5
5. Metals Handbook
6. Aerospace Structural Metals Handbook
7. EFV Program Mandated Hazardous Materials - http://www.deq.state.va.us/veep/gdamsreport.pdf

KEYWORDS: Titanium, Castings, Low Cost, Mechanical Properties, Corrosion, EFV components, quality, durability, producibility, hazardous materials

N04-154 TITLE: Fuel Cell Supply Integration and Safety

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT IV: PM Expeditionary Power Systems

OBJECTIVE: To identify, develop and demonstrate necessary technology and means to safely transport and distribute potential fuels for small fuel cell systems (20-100 watts electrical output)

DESCRIPTION: Fuel cell technology as an alternative power source for tactical systems is quickly becoming a viable option. Forecasted development of this technology within the near future provides the embarked Marine an enhanced capability in reducing the logistics footprint and extending mission capability.

PHASE I: For small man-portable fuel cell systems that could replace BA-5590 batteries (12 or 24 volt DC, 170 watt-hours, 24-hour run-time) as envisioned for extended run-time systems (12/24 volt DC, 7 day run-time) such as intelligence suites or infantry weapon systems, the contractor shall research, develop and/or modify prototype hydrogen and methanol storage and distribution systems as a packaged fuel system, and address Naval aviation and Naval surface ship transportation modes and criteria (10g longitudinal, 3g lateral, 3g vertical, 160 degree F storage, saltwater submersible). This effort shall address storage, transportation and use of hazardous material and compliance with Department of Transportation (DOT) and Department of Defense (DOD) regulations. Research, analysis, trade-offs, and documented traceability to host requirements will be assessed for types of packaging materials and containers to reduce costs and wastes and emergency response to transportation or storage accidents will be reviewed.

PHASE II: Using results from Phase II, the contractor shall provide and conduct testing of at least two working prototype systems (fuel, containers, packing, and shipping systems) that meet the system safety requirements in accordance with applicable commercial standards, DoD, Environmental Protection Agency (EPA) and DOT regulations. The contractor shall identify and evaluate system safety and health hazards to determine the probability and severity of hazards associated with development, use, reuse, and disposal of the system and the fuels.

PHASE III: The contractor, in accordance with commercial and federal safety standards, shall safety qualify the fuel transportation and storage system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied in any work environment where there is a requirement for exportable and transportable power and energy systems. Any battery-powered systems envisioned to use small fuel cells in the future would benefit from this project. Infrastructure for transportation and storage remain the limiting factor to the widespread use of fuel cells.

REFERENCES:
1. Mil-STd-1366D "Interface Standards for Transportability Criteria" and AR-70-44 "DOD Engineering for Transportability"

KEYWORDS: fuel, cell, distribution, storage, generation, transportation, recycling, hazardous waste, training, tactical power

N04-155 TITLE: Sensor for Simultaneous Movement and Directed Weapons Fire in Day/Low/No-light.

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Human Systems

ACQUISITION PROGRAM: PM Infantry Weapons, Target Acquisition

OBJECTIVE: To provide an all-light optical sighting system that allows for movement and directing weapons fire simultaneously while enhancing Marine survivability.

DESCRIPTION: The USMC infantry currently uses at least two separate methods of employing night vision systems to direct weapons fire and to conduct movement in low-light and no-light conditions. To direct weapons fire, Marines use night vision weapon scopes and/or thermal weapon sights in a passive mode of operation; or Marines (a majority) use night vision goggles/monocular combined with an infrared laser pointer (PEQ-2a) for target designation in an active mode. To move, however, the infantry must use a PVS-7 night vision goggle or a PVS-14 monocular night vision device. When in passive mode, a Marine must switch sensor devices while transitioning from directing fire to movement. This creates an added burden of carrying multiple sensor systems and also increases the vulnerability (and reduces the effectiveness) of the Marine during transition periods. Operating in active mode is inherently a vulnerable method of operation as the same laser used to designate a target also "gives away" the users position. Furthermore current night vision goggles and monoculars limit mobility because of inadequate depth perception, failure to remain aligned with human eye during movement and increased weight and balance problems on the head or helmet. Further still is the total inadequacy of night vision goggles/monoculars in no-light conditions.

A Marine Corps Combat Development Command (MCCDC) sponsored study for future optical capabilities has identified a single system indirect view sensor as a potential future capability that eliminates most of the above mentioned deficiencies. This technology incorporates an indirect view head/helmet mounted display (HMD) for improved ergonomics and functionality while moving, and a fused sensor suite. The HMD displays the visual field imaged by the sensor(s) with the addition of an overlaid weapon bore sight reticle (tracking of weapon aim point relative to fused sensor visual field). In this manner the Marine can acquire and engage targets in his sensor field of view, and move seamlessly in all light levels. The sensor suite may consist of the fused output of various daylight, image intensifiers and thermal imagers to provide all light capability. Sensors may be Marine-borne or weapon-borne.

This capability requires that disparate sensor views (independent random 3-D spatial orientations) be located, tracked, registered and displayed on a single HUD.This capability also requires disparate sensor fields of views (independent random 3-D orientation and differing fields of view) to be tracked registered, scaled and overlaid/fused in real time.

A fused indirect view sensor system will provide an all-light level capability to simultaneously move and engage targets in all terrains (including MOUT). Furthermore, since the system will operate in a passive and require no transition between movement and target acquisition, will inherently be more effective and reduce the vulnerability of the individual user.

PHASE I: Design a system for the dismounted infantry that provides for a capability to simultaneously move and acquire targets in all light levels. This design could incorporate multi sensor fusion and a helmet/head mounted display with an overlaid weapon sight aim point and fused sensor views. The design shall incorporate a trade-off study (with the input of operational Subject Matter Experts) to determine sensor types, fusion methodologies, sensor location, display type, ergonomics and operational compatibility.

PHASE II: Develop, test and deliver a prototype sensor system. The prototype shall be tested and evaluated for adequacy in providing situational awareness for simultaneous movement and target acquisition in all light levels and all terrains. The system shall be evaluated for operational compatibility, ruggedness and maximum performance.

PHASE III: Collect operational use data and evaluations. Modify, harden and test the system for military use. Prepare operators/training and maintenance instruction for the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The system as described could be extremely useful for night security, rescue operations, riot control and local/state police activities. The system as described may also find a market with hunters and nature watchers. The system has commercial application is the areas of remote sensing and robotics. If not already available the system (with different sensors) could find application in medical surgery.
Keywords: sensor fusion; thermal imagers; image intensifiers; night vision; helmet mounted display; head mounted display; indirect view optics; target acquisition; weapon sight

KEYWORDS: sensor fusion; thermal imagers; image intensifiers; night vision; helmet mounted display; head mounted display; indirect view optics; target acquisition; weapon sight

N04-156 TITLE: <u>New Modeling and Simulation Technology for Night Vision Goggle Mission Rehearsal</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop modeling and simulation technology that will supplement navy requirements for night vision goggle (NVG) instruction and provide mission rehearsal for ground and aviation operations.

DESCRIPTION: The Navy is seeking new technology that will provide NVG instruction and mission rehearsal in a format that is operationally relevant, modifiable (terrain, weather, mission, etc.) and cost efficient. Current training consists of simplistic physical board models (20X 20 foot terrain board) for basic orientation to NVGs and how to fit, adjust, and operate the hardware. The aircrew use their own NVGs to visualize a limited number of illusions produced by electro-optic devices. These illusions are limited to a few shadows X moonlight illusions and a limited number of lighting generated effects. There is no capability to provide meaningful and realistic cultural features for training, no opportunity to train under more difficult scenarios (variable weather/obscuration, cultural lighting, other aircraft, battlefield effects), and no ability to train with variable terrain or operationally relevant scenarios (i.e., mission rehearsal).

Although there have been research advances in both physics-based electro-optical simulation (which allows modeling of weather effects) and in the materialization of databases to allow accurate modeling, there are technological hurdles to integrating these two capabilities. Even in large tactical operational flight trainers (TOFTS) there is limited physics-based NVG simulation that incorporates weather/obscurations and battlefield effects. Current mission rehearsal/preview capability (i.e., TOPSCENE) does not include realistic NVG representations. Current technology is not capable of providing the ability to realistically simulate electro-optics systems in different missions or with changes in the local environment (i.e., weather). Some of the technical challenges to be addressed include: (1) Data compression techniques to produce realistic, materially (and culturally) encoded visual databases; (2) NVG simulation versus stimulation evaluations for optimal field-based NVG training; and (3) Development of accurate models (and encoding techniques) for weather and obscuration effects on current generation NVG emitter tubes.

PHASE I: Determine the technical feasibility of a portable NVG modeling and simulation technology that will meet mission rehearsal training requirements.

PHASE II: Design, develop, and demonstrate the prototype modeling and simulation technology that can function independently in an operational environment. Demonstrate and evaluate the prototype in a training environment currently serviced by NITE Labs.

PHASE III: Enhance the prototype developed in Phase II and co-locate it with a previously designated NITE Lab. Transition the prototype system to a designated organization.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are many commercial training applications for cost effective NVG modeling and simulation technology. Numerous law enforcement agencies (e.g., police/sheriff's departments, FBI, Customs) throughout the world use NVG devices and could benefit from new training systems based on technology from this SBIR.

REFERENCES:
1. Waggett, M.L. "Night Vision Goggles Computer-Based Training." Maxwell AFB, Alabama: Air Command and Staff College, 1999.
2. Shaffer, K.J. "Re-Engineering a Computer-Based Trainer for a Helicopter Night Vision System." Monterey, California: Naval Postgraduate School, 1996.
3. Epperson, S.T. "Animation Within a Multimedia Training System for Night Vision Goggles." Monterey, California: Naval Postgraduate School, 1995.
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KEYWORDS: Night Vision Goggles; Training Technology; Simulation; Computer-Based Training; Environmental Effects; Mission Rehearsal Training

N04-157 TITLE: <u>High Force Electric Linear Actuator</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT ID, PMS378

OBJECTIVE: Develop a cost-effective, efficient, compact, high force electric actuator for use in a variety of naval applications. This electric actuator should be able to provide very high force levels in a lightweight compact arrangement.

DESCRIPTION: The Navy is interested in pursuing electric actuator technologies that far exceed existing actuators in capabilities and performance. Typical existing electric actuators have several drawbacks, including excessive size and weight, backlash, and excessive power requirements and losses, which result in thermal management problems. Typical existing hydraulic actuators are large and bulky and require a significant amount of maintenance; they also typically involve hazardous materials.

Aircraft Carrier Weapons Elevator hydraulic subsystems include elevator hatches, doors, door dogging devices, door-latching mechanism, hatch securing pins, ramp operators, hinged rails and jet blast deflectors. Centrally located Hydraulic Power Units (HPU) provide pressurized fluid to all of the hydraulic subsystems and electric actuators are required for all of these applications in order to eliminate the entire HPU system. Two of the Navy high force applications that require the development of a high force electric linear actuator system are aircraft carrier weapons elevator flight deck hatches and jet blast deflectors. Both of these applications require a system of linear actuators with a force of 60,000 lbs per actuator to accelerate and move the hatch/deflector through the full range of travel. The flight deck hatch is required to open from the horizontal position to 90 degrees in 20 seconds with a stroke length of 43 inches. The required actuator linear maximum stroke speed is 4 inches per second. The cycle rate is 16 cycles per hour for 10 hours per day. The jet blast deflector is required to open from the horizontal position to 60 degrees in 6 seconds and close in 8 seconds. Both of these applications will require two synchronized actuators for operational stability. Each actuator shall include a brake capable of stopping and holding the load at any position in the length of stroke. The brake shall be fail-safe such that it will automatically be applied upon power loss and will be capable of stopping the actuator and it's connected load at full speed within a distance of 6 inches. A spring reset manual brake release shall be provided for the brake so that opening of the connected load by alternate methods is possible without disconnecting the actuators from the load. The size and weight of each actuator assembly shall be minimized to the fullest extent practicable to minimize impact ship structural arrangements. The actuators shall be designed to resist damage or degradation or performance due to exposure to rain, ice, snow, saltwater spray, high humidity, JP-5, and AFFF. The actuator shall meet all performance requirements throughout an ambient temperature range –10 to +150 degrees F and an atmosphere of relative humidity between 5 to 95 percent. A passive cooling system is desired for the electric actuator system. The actuator system shall be designed to operate from ship 440 VAC, 60 Hz, 3-Phase electric power.

PHASE I: Using Naval requirements, define a set of metrics for comparison against existing technologies. Develop an innovative electric actuator concept that excels compared to the metrics. The concept should include notional principles or operation, major component dimensions and weights, system power requirements and performance capabilities, and detailed drawings of the actuator system including the actuators assemblies, actuator drive assemblies, system power supplies and controls. Develop a modular approach to the actuator design that will allow the actuator to be scaled up or down to meet the full range of force, stroke and speed requirements for Navy shipboard applications, including cargo and weapons elevator and jet blast deflector applications.

PHASE II: Design and build a prototype actuator system for the aircraft carrier hatch with the required force, stroke, speed, cycle rate and interface connections. Demonstrate the actuator system to the full range of force, stroke and speed. Demonstrate the cost and produceability of the electric actuator systems.

PHASE III: Produce a full-scale electric actuator system that would be tested in a realistic environment under realistic operational scenarios.

Build a family of actuators that are scalable to meet the variety of U.S. Navy requirements and applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are many commercial applications for high force electric liner actuators where hydraulics and pneumatics systems are currently utilized including the automobile industry. Efficient, compact high force actuation would have a profound effect on the commercial sector. These actuators could by used in a plethora of applications, from material handling and manufacturing to elevators and amusement applications.

REFERENCES:
1. MIL-S-901D, Shock Requirements

2. MIL-S-167-1, Vibration Requirements

3. MIL-STD-461E, EMI Requirements

4. MIL-STD-810F, Environmental Engineering Considerations and Laboratory Tests

5. Military Specification MIL-E-17807 Cargo and Weapons Elevator

6. Naval Ships' Technical Manual Chapter 772 Cargo and Weapons Elevators

KEYWORDS: High Force Actuator; Electromagnetic; Electric Actuator; Linear Motion; Electromechanical; Electrical Motors

N04-158 TITLE: High Flux Density Magnetic Materials

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT ID: PEO Aircraft Carriers, PMA215C, PMS312, PMS378

OBJECTIVE: Develop a cost-effective, high flux density magnetic material for use in electromagnetic and electromechanical devices allowing for higher power and energy densities.

DESCRIPTION: The Navy is interested in pursuing material technologies to provide cost-effective, high flux density magnetic material that could operate at a minimum of 2.2 Tesla without saturating. This material would be the same as or better then traditional silicon steel (such as M-19) in its mechanical properties but would be able to operate at the higher flux densities without saturating. In order to be viable for this application the material must exhibit a cost effective combination of the increased flux density, and same or reduced mass density of traditional silicon steel. Since less material would be used to accommodate the same flux density, the weight and volume of the motor or generator would therefore be less. Reduced weight and center of gravity make ships more stable and buys back service life allowance. Such technologies could be transitioned to the electromagnetic aircraft launch system (EMALS) program, which seeks to replace current steam catapults aboard aircraft carriers with an electromagnetic means of launching aircraft.

PHASE I: Assess the feasibility of developing innovative materials that would meet the requirements described above. Prove, through analysis and hardware demonstrations, that the concept(s) could meet the stated requirements.

PHASE II: Demonstrate a small-scale electric motor that uses the high flux density magnetic material and verify its performance advantage. Demonstrate the cost effectiveness and produce-ability of the material. Provide cost estimates and proof of scalability to full-scale linear motor.

PHASE III: Produce a full-scale linear motor that could be tested at the EMALS test site at NAVAIR Lakehurst. A successful material could be integrated into EMALS aboard future carriers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High flux density magnetic materials could have a profound effect on the commercial sector. These materials could provide for higher power and energy dense motors and generators, thereby reducing their size and weight. This is important to the future of locomotives, aircraft, spacecraft, and electrical vehicles. While high flux density magnetic materials exist, they are cost prohibitive for all but the most extreme uses. A new, cost effective material would open many applications to the benefits mentioned previously.

REFERENCES:
1. Metals Handbook, Vol.1, 8th Ed., p.792

2. ASTM Method A 343

3. "The benefits of Electro Magnetically Launching Aircraft", Naval Engineering Journal, May 2000, Vol. 112 #3

KEYWORDS: High Flux Density; Electromagnetic; Aircraft Launch System; Silicon; Electromechanical; Electrical Motors

N04-159 TITLE: Automated Generation and Control of Robust, Real-Time Simulation Environments

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT I: PMS 450 SSN 774 VIRGINIA Class Submarine

OBJECTIVE: Conceptualize, Design and develop a robust simulation/stimulation generation and control capability that will provide real-time-adaptable simulated environments for tactical systems with more intuitive control and visualization.

DESCRIPTION: The Navy develops simulated tactical environments with which to conduct system development, integration, testing, certification, training and life-cycle support. These environments lack robustness and fidelity and are very limited in the ability to control and direct in real time. The current state of the practice is use of “canned” scenarios to provide the simulated environments without the robustness of a real-time, reactive environment. The effort required to generate these canned tactical environments is complex, labor intensive, and costly.

Real-time scenario generation, control and system stimulation is needed with the fidelity to create a dynamic scenario of real world “tactical and environmental entities”. Advances in controls and visualization of these dynamic scenarios are needed to provide robust, real-time control. If developed, this robust simulation/stimulation capability could be effectively used for a myriad of military applications including system integration, testing, certification, training and life-cycle support purposes.

The scope of this research is envisioned to entail exploration of new concepts of operation in system simulation, stimulation and advanced control derived from emerging tactical system technology, such as Agent Base Systems (ABS), Control of Agent Based Systems (COABS), and recent advances in synthetic environments, real-time modeling, simulation and their control.

PHASE I: Exploring the technologies emerging from advanced tactical Command, Control, Communications and Intelligence (C3I) Systems and new thinking in synthetic environments and simulation control, develop a system concept of operation for robust, real-time simulation/stimulation control capability that can generate real-time simulated environments. Conduct an analysis of the feasibility to meet goal-directed scenario generation and control based on emerging technology and the new system concept of operations. Identify options to demonstrate feasibility.

PHASE II: Building on the results of Phase I, define a notional system to facilitate a demonstration of system concepts and feasibility. Develop a prototype implementation that demonstrates the concepts of operation and the feasibility to generate and control tactical simulations/stimulations using high-level, goal-directed operator control.

PHASE III AND DUAL USE APPLICATIONS: The logical progression for this capability would be to develop a real-time-controlled simulation/stimulation environment, integrate, test and certify the improved scenario generation function with tactical and training systems.

This capability could be used in a broad range of military and commercial applications where real-time, goal directed control of complex simulations and stimulations are required. For example, this new concept could be of value to Homeland Security situational assessment training, to war-gaming and Fleet Battle Experiments where complex modeling, simulation, and scenario generation and control could be performed in real time.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced simulation control systems, military training systems, commercial training systems, civil preparedness planning and training, and mission planning systems. This new concept could potentially be applicable to a myriad of simulation control applications, both military and commercial, that require robust real-time control. For example, this new concept could have commercial value in the markets of Homeland Security (e.g. situational assessment training), war-gaming or Fleet Battle Experiments where complex modeling and simulation, scenario generation and control could be performed in real time. The knowledge base derived from work surrounding this topic could also be applicable to tactical information systems.

REFERENCES:

1. Enabling Technologies for Modeling and Simulation, http://www.msrr.dmso.mil/
2. Control of Agent Based Systems, DARPA, http://coabs.globalinfotek.com/
3. Zeigler, B. P. 1990 "Object-Oriented Simulation with Hierarchical, Modular Models", Academic Press/Harcourt Brace Jovanovich.
4. Automated scenario generation (SGEN), Walter Koziarz
5. Fishwick, P. A.. 1995. "Simulation Model Design and Execution - Building Digital Worlds", Prentice Hall Publishers.
6. Sisti, A. F., and Trott, K. C. 1996. "SYNBAD: A Distributed Interactive Simulation (DIS) Environment for C3I Capability Assessment", Rome Laboratory Technical Report.
7. C2-led Simulation and Synthetic Environments for Air Operations, Karyn Matthews and Mike Davies

KEYWORDS: Generation and control of real-time simulation; simulation systems; training systems; modeling and simulation; information technology; operator-machine interface; visualization;

N04-160 TITLE: Synthetic Lubricating & Hydraulic Oil for Motion Control, Steam Turbines and Gears, Military Symbol 2190-TEP Replacement

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT I (Submarine Program Office PMS392)

OBJECTIVE: Research new chemical lubricant technologies to develop an improved generation of fully synthetic oils for use aboard Navy submarines in their lubricating, hydraulic, steam turbine and gear applications, both in the propulsion plant and in selected shipboard auxiliary systems. Navy submarines continue to experience substantial system performance degradation over time with existing oils formulated and procured by military specification. Navy submarine platforms in particular sustain excessive oil related Fleet material casualties associated with system fluid oxidation, contamination, component failure and pre-mature system fluid replacement. In addition, increasingly high oil replacement and disposal costs consume dwindling Fleet maintenance dollars. The objective of this SBIR effort is to deliver newly formulated, high quality synthetic oils to the Fleet that are capable of extended operating service life, and exhibit a high resistance to the fluid degradation and oxidation phenomena that is documented in military specification oils today.

DESCRIPTION: This topic is focused to research, develop, formulate and produce a completely new moderate service synthetic lubricating & hydraulic fluid that will lower shipboard maintenance costs, improve the operational readiness of various critical ship systems, and extend the performance service life of high precision propulsion and motion control devices shipboard. Existing MIL-PRF-17331 (mineral) organic petroleum based military symbol 2190-TEP fluid no longer performs acceptably at sustained high performance levels for extended service life with Navy submarine platforms. Some Navy submarines have experienced high depletion rates of fluid anti-oxidant (AO) additive packages, sharp increases in fluid Total Acid Number (TAN) and severe off-gassing events during the extended operation of (mineral) organic petroleum based system fluids. Any proposed replacement fluid must demonstrate the ability to maintain robust anti-oxidant characteristics, sustained degradation resistance, a high tolerance to contamination from water and particulate, and the ability to perform with bacterial and fungal growth within the shipboard system and essential mechanical components.

This topic also includes additional direct technical issues related to the environmental impact associated with excess oil disposal and pre-mature recycling of existing service fluids, as well as various shipboard and shore-based personnel hazards.

PHASE I: Research petroleum fluid formulation technologies, investigate and identify new fluid compounding/synthesis techniques, develop and model prototype system fluid formulations. Demonstrate this research and development effort in a shop, laboratory environment or facility determined by the contractor.

PHASE II: Produce sample fluid formulations for review and evaluation by NAVSEA engineering subject matter specialists. Document available synthetic formulation technologies, equipment and processes used to produce these new fluid product formulations. Complete a prototype demonstration of new fluids of the contractors choice.

PHASE III: Conduct full series fluid physical properties testing in a Navy/marine engineering environment, or commercial facility. Prepare a descriptive engineering technical data package needed to commercially synthesize the new fluids. This package will be constructed so that a new system fluid can be easily manufactured utilizing "commercial off the shelf" (COTS) techniques and materials or readily available raw materials sourced in the open marketplace. Conduct, as needed, selected shipboard visits and examine ship system fluid applicatios for submarine force engineering platforms. Produce new fluids for potential Fleet temporary alteration (TEMPALT) or shipboard system installation and/or evaluation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: 1. Marine Oils and Lubricants, Cargo and Container Shipping, Coastal & River Service Craft/Tug Boats, Cruise and Passenger Ship, Commuter Ferry Boats, Shore Based/Port Side/Land Facility Heavy Cargo Handling Equipment Operations. 2. Waste Oil Environmental Recovery Operators - Bulk Used Industrial Oil Processing & Safe Disposition, Hazardous Spill Clean-up and Restoration Activities.

REFERENCES:
1. Military Specification MIL-PRF-17331, (Lubricating Oil, Steam Turbine and Gear, Moderate Service), Naval Surface Warfare Center (NSWC) Philadelphia, PA Code 622 "Submarine Fluid Evaluation Reports", National Fluid Power Association Test Requirements, Hydraulic Institute, Fluid Power Society, OilAnalysis.com (Noria Corporation, Tulsa, OK).

KEYWORDS: synthetic oils, marine petroleum products, shipboard fluid power, ship motion control, control surface actuations, safety of ship operation.

N04-161 TITLE: Simulation Environment for Complex, Man-in-the-Loop, Real-Time Systems

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: ACAT II: PEO IWS 1S, Open Architecture Program Office

OBJECTIVE: Enable analysts to evaluate and do trade-off performance and cost analyses of components of a real-time, distributed, computing environment within the network centric battlefield environment. The environment will involve extensive human interaction and direction.

DESCRIPTION: As the DoD community works towards improving the interoperability of its systems, it is currently investigating a variety of ways to re-architect the required functionality to ensure a more effective and lethal war fighter. However, these activities seem to be focused on the implementation of a solution without having an effective way to model the complex environment that exists within the network centric battlefield. To effectively model this environment and to perform root cause analysis prior to actually implementing a solution, a command and control discrete event simulation environment is needed. Discrete event simulations would allow the modeling of the arrival of command and control orders and the time required for humans to serve them, which is extremely useful for predicting workload and possible areas of system saturation.

This simulation environment would allow for the variability that can occur in combat by allowing the user to inject different battlefield scenarios that incorporate aspects of human intervention, enemy actions and the ability to postulate the results of different planned responses by the various battlefield elements. For example:

* How human decisions at various places in a C2 network affect the bigger picture, specifically the impact of time delays, arrival of unanticipated events, and incorrect decisions.

* Assessing workload of operators/pilots/C2 leadership as a function of communications either through voice or data link. This could help to model potential manning requirements for various operational tempos.

* How would breakdowns in communications, and either prolonged or incorrect decisions would have on various key bottlenecks in a C2 network.

* Use the simulation to explore the impact of extreme events, which would either be impossible or very costly to simulate in an actual network.

PHASE I: Develop the framework of a simulation environment that would facilitate the construction of a given or proposed distributed, real-time system architecture within a battlefield environment. The graphical user interface would allow rapid construction of the distributed environment and the connecting network structure. The simulation environment would facilitate metrics identification, collection, and reporting in the areas of performance, human factors, dependability, cost, etc. for evaluation and assessment of proposed technology insertions within a candidate open architecture environment.

PHASE II: Develop a prototype simulation environment that implements the features described above. Demonstrate the utility of this environment on a candidate technology that is being evaluated in the Navy's EDM(0) environment and compare the two results. Look at performance; human factors analysis; dependability and cost measurements of the technology. Show various scenarios can be quickly analyzed using the candidate technology and that various trade-offs can be performed.

PHASE III: Prepare a, user-friendly simulation environment with supporting documentation for use in modeling and simulation, human factors, and performance analysis of distributed, real time systems that are highly heterogeneous in nature in the context of civilian and military work environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied in any work environment involving a distributed, computing environment where there is extensive decision making involved.

REFERENCES:
1. Kelton, D., R. P. Sadowski, et al. (2002). Simulation with Arena. Boston, McGraw-Hill.

2. Law, A. M. and D. Kelton (2000). Simulation Modeling and Analysis, McGraw-Hill.

3. Wetteland, C. R., J. L. Miller, et al. (2000). The Human Simulation: Resolving Manning Issues Onboard DD21. Winter Simulation Conference.

KEYWORDS: Simulation; performance; cost; dependability; evaluation; assessment; human factors; trade-off analysis

N04-162 TITLE: High Power Limiters based on Silicon Carbide (SiC), and Gallium Nitride (GaN) Device Technology for Phased Array Radar (L,S and X-Band), Communications and EW Applications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 2.0 Radar Systems Division

OBJECTIVE: Develop, and demonstrate a high power limiter technology, providing power handling capability that is 4-5 x the power handling capabilities of current Silicon PiN diodes, or GaAs FET based limiters.

DESCRIPTION: Future radars will use power amplifiers with 4 - 5x the power of today's amplifiers and these radars will have very large effective radiated powers. Receiver protection technology exceeding the current state of the art must be developed to protect the radar T/R modules not only from transmitter leakage but also from external EMI and jamming. This technology is critical to the successful introduction of advanced high power amplifier technologies. Concepts, devices, and advanced receiver protection technologies are sought, which can satisfy projected advanced radar system requirements. Research or Research and Development efforts selected under this topic shall demonstrate and involve a degree of technical risk where the technical feasibility of the proposed work has not been fully established. MMIC Limiters based on Wide Bandgap materials will be of great interest, as will be low cost hybrid based designs.

PHASE I: Analyze, design and conduct proof-of-principle demonstrations of advanced limiter devices, as well as a preliminary limiter design that will lead to the successful demonstration of the technology.

PHASE II: Develop and demonstrate prototype devices providing stable device performance while handling 4-5X the power of currently available devices. Develop and demonstrate new processes (or hardware) that lead to production of improved devices.

PHASE III: Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications. Produce production quality power limiter.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced limiters have application throughout commercial industries. Commercial radars, communications equipment, cell phones, satellites and the electrical power industry would benefit from this development.

REFERENCES:
1. Shur, M.S., "GaN-Based Electronic Devices", International Technology Research Institute, TTEC Report August 2000

2. Chow, T.P., "High Voltage SiC Power Devices", International Technology Research Institute, TTEC Report August 2000

3. Sze, S.M., Physics of Semiconductor Devices, john Wiley & Sons 1981

4. White, J. F., Microwave Semiconductor Engineering, Van Nostrand Reinhold Ltd. 1982

KEYWORDS: High Power Receiver Protection, Limiter, SiC and GaN transistors; SiC and GaN Schottky diodes; SiC and GaN PiN Diodes; Transmit/Receive Module; X-band; S-band; Radar; EW; Communication Equipment

N04-163 TITLE: Active Radar System Thermal Management

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: IWS 2.0 - Radar Systems Division

OBJECTIVE: Develop innovative and cost effective high power RF amplifier thermal management techniques capable of supporting wide bandgap power densities.

DESCRIPTION: Current microwave power amplifier technology support power densities of nearly one watt per square centimeter. Amplifiers currently under development may operate at 2-4 times this power density. Higher power levels of future Navy advanced radar antenna systems require state-of-the-art capabilities for waste thermal energy acquisition, storage, transport, and dissipation. Technology advancements are required in ther-mal management for power generation systems, T/R modules, and all associ-ated electronics. Of specific interest are concepts to transfer heat from high power T/R modules to a heat dissipation system. Concepts, devices, and advanced technologies for all types of power cycles are sought that can satisfy projected advanced radar system requirements.

PHASE I: Demonstrate the likelihood that a new and innovative mate-rial or technique can support the reliable operation of power amplifiers operated at the power densities under consideration.

PHASE II: Develop applicable and feasible prototype demonstrations and/or proof-of-concept devices for the approach described, and demon-strate a degree of commercial viability.

PHASE III: Develop pre-production and production components and sub-systems for integration into Navy advanced radar systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These technologies could be applied in many RF applications such as the telecommunications industry, commer-cial airport radar systems, and automotive industry.

REFERENCES:
1. R. Kirschman (ed.), “High-temperature electronics”, IEEE Press (New York, 1999).
2. P.L. Dreike et al., “An overview of high-temperature electronic device technologies and potential applications”, IEEE Trans. on Components, Packaging and Manufacturing Technol., pp. 594-604 (1994).
3. Weimer, “Thermochemistry and Kinetics”, Carbide, Nitride and Bor-ide Materials Synthesis and Processing, edited by A. Weimer, Chapman and Hall, New York, 79-113, (1997)
4. Ortega, A., Agonafer, D, and Webb, B. W., Eds, “Heat Transfer in Electronic Equipment,” ASME HTD, Vol. 171, 1991.
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8. J.P. Holman, Heat Transfer, Fifth Edition 1981, McGraw-Hill Book Company.
9. Mallik, A.K.; Peterson, G.P.; Weichold, M.H. “On the Use of Micro Heat Pipes as an Intregal Part of Semiconductor Devices”, Proceedings of the 3 rd Joint Conference of ASME-JSME Thermal Angering, 1991 Pg 393-401.
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11. W.C. Nieberding, J.A. Powell, “High-temperature electronic re-quirements in aeropropulsion systems”, IEEE Trans. Industrial Electronics, pp. 103-106 (1982).

KEYWORDS: radar; T/R module; HPA; Wide Band gap; High Voltage GaAS; thermal management; power; RF; antenna array

N04-164 TITLE: <u>Electronic Warfare (EW) System Direction Finding (DF) Interference Suppression</u>

TECHNOLOGY AREAS: Electronics, Weapons

OBJECTIVE: Provide Navy EW Systems with Interference Suppression for the DF subsystem. The objective is to reduce filtering associated with a multi-channel design and architecture like that of the AN/SLQ-32 through processing or rejecting digitally modulated Continuous Wave (CW) signals.

DESCRIPTION: The US Navy and Fleet’s number one priority for Navy Surface EW is to resolve the topside Electromagnetic Interference (EMI) issues between SATCOM and EW systems. Navy EW DF Subsystems are susceptible to digitally modulated CW signals. The AN/SLQ-32 Instantaneous Frequency Measurement (IFM) subsystem handles this through a series of switched fixed notch and tunable notch filters known as the interference suppression upgrade. This effort is to provide a cost effective version of the IFM interference suppression to the DF subsystem, focusing on handling the digitally modulated CW signals through processing and/or rejection. This topic is unclassified and no classified proposals will be accepted.

PHASE I: Identify cost effective and innovative concepts for handling digitally modulated CW signals. Analyze options through modeling and provide pro's and con's for each.

PHASE II: Demonstrate technology through prototype testing in a lab and shipboard environment.

PHASE III: Develop a production model and qualify it for shipboard use. Determine viability and applicability for commercial sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Although the specific subsystem developed under this submission would not be commercially viable, the methods and technology developed would be useful in many areas of telecommunication for prevention and/or suppression of inter- and intra-system interference.

REFERENCES:
1. AN/SLQ-32 Technical Manuals (all volumes) SE400 M3 MMO xxx/(U) SLQ 32A (V), Published by Direction of Commander, Naval Sea Systems Command, 1990.

2. PSK EMI Mitigation Requirements Document NSC-Q32-2002-070, Brandon Sisley, 2003.

Please Note: There are no other unclassified references.

KEYWORDS: Interference Suppression; CW Signals; Digital; Processing; Rejection; DF Subsystem

N04-165 TITLE: <u>AN/SLQ-32 IFM/CFR upgrade</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: ACAT II: Surface EW Improvement Program (SEWIP)

OBJECTIVE: Provide the AN/SLQ-32 with finer frequency resolution, less interference between Band 2 and Band 3 processing, the ability to operate within the shipboard Radio Frequency (RF) environment, and the ability to measure the Pulse Width of incoming signals.

DESCRIPTION: The Instantaneous Frequency Measurement Course Frequency Receiver (IFM/CFR) provides the AN/SLQ-32 with the capability to measure the frequency of an incoming signal. It is the only location within the AN/SLQ that Band 2 and Band 3 processing is mixed.
The IFM Multiplexer (MUX) divides the RF spectrum covered by the AN/SLQ-32 into seven sub-bands. It then mixes the signals for those seven sub-bands down to a single frequency range and presents seven signals, one for each sub-band, to the IFM/CFR. The sub-bands are numbered sequentially starting at the low frequency for sub-band 1 and the high frequency is sub-band 7.

The IFM/CFR processes these signals in three main areas: 1) Signal presence for timing and control, 2) CW detection for filter tuning, and 3) Frequency determination. The architecture of the IFM/CFR combines the odd numbered sub-bands (1, 3, 5, & 7) into a group called channel A and the even numbered sub-bands (2,4,6) into a group called channel B. These channels are designed so only one can be active at a time, and within a channel, only one sub-band can be active. Due to this arrangement, only one signal across both Bands can be processed at a time, even though the rest of the system is designed to process Bands 2 and 3 separately. This presents significant processing limitations within the current system.

The IFM/CFR uses frequency discriminators that measure the frequency by measuring the phase difference of the

signal and a delayed signal. Continuous wave (CW) signals interfere with this frequency measurement. To correct this, the AN/SLQ-32 uses tunable notch filters to reject CW signals, which is not the ideal method for handling CW signals.
The goal of this project is to provide the AN/SLQ-32 with a single unit that provides the current functionality of the IFM/CFR and includes the following improvements:
1) Completely separates the Band 2 and Band 3 processing.
2) Ability to process pulsed signals in the presence of CW Signals including the digitally modulated CW signals.
3) Improved Frequency Resolution.
4) Pulse Width measurement capability.
This topic is unclassified and no classified proposals will be accepted.

PHASE I: Identify innovative, cost effective design concepts for a new IFM/CFR design that incorporates the desired upgrades. The new unit should be a drop in replacement (except additional data transfer requirements for the finer frequency resolution and pulse width) for the existing IFM/CFR.

PHASE II: Build a prototype and test the new or modified IFM/CFR in a lab and shipboard environment.

PHASE III: Develop a production model of the new IFM/CFR and qualify it for shipboard use. Determine viability and applicability for the commercial sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Although the unit developed under this submission would not be commercially viable, the methods and technology developed would be useful in the telecommunications arena, specifically in the enforcement of Federal Communications Commission (FCC) guidelines.

REFERENCES:
1. AN/SLQ-32 Technical Manuals (all volumes) SE400 M3 MMO xxx/(U)SLQ 32A(V), Published by Direction of Commander, Naval Sea Systems Command, 19902)

2. Frequency Measurement and Control, Chronos Group, 1993.

Please Note: There are no other unclassified references.

KEYWORDS: Frequency resolution; Pulse width; Shipboard RF environment; Interference; Signal processing

N04-166 TITLE: Fiber Optic/Electrical Lightweight Tow Cable for Optical Towed Arrays

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics, Battlespace

OBJECTIVE: Develop a neutrally buoyant fiber optic/electrical tow cable for Navy optical towed array sonar applications.

DESCRIPTION: The Navy is developing passive optical acoustic sensor technology for use in future Navy towed arrays. To deploy these arrays from tactical platforms, innovative solutions are required to developing lightweight, torque balanced, hybrid fiber optic/electrical tow cables. It is desired that the tow cables have at least 14 continuous-length single-mode optical fibers with low optical loss and two electrical conductors in a 0.375 inch maximum cable diameter. Innovative solutions are needed to minimize optical bend-loss and to minimize optical phase and polarization modulations during tow, to reduce the specific gravity of the cable (with an objective of neutral buoyancy in seawater), and to limit tow cable rotation.

PHASE I: Develop a conceptual design(s) of the required tow cable; model the concept(s) to identify the major technical risks; identify design solutions to meet the requirements.

PHASE II: Develop, test, and demonstrate prototype tow cable designs against the mechanical, optical, electrical, and environmental requirements.

PHASE III: Produce fiber optic/electrical tow cables for military and civilian towed arrays.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Fiber optic towed arrays are currently being developed by both the Navy and the commercial geophysical survey community for underwater activities. Developing a lightweight, torque balanced fiber optic tow cable assembly will place the developer in an excellent position to bid on related Navy and commercial requirements.

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KEYWORDS: Tow Cable, Fiber Optics, Towed Array, Torque Balanced

N04-167 TITLE: Virtual RF Tactical Communications

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: Integrated Warfare Systems, Total Ship Training Systems

OBJECTIVE: Enable Fleet personnel to establish tactical voice communications among physically displaced ships and shore sites utilizing new digital networking technology while preserving the "feel" of their actual Radio Frequency equipments.

DESCRIPTION: Current in-port battle force training strategy relies on line-of-sight radio technology at each Fleet concentration area and utilizes obsolescent radio, audio, and telecommunications equipment to link together ships, and their crews, that are physically displaced in a wide variety of naval ports. Execution of the proposed SBIR would expand the application of newly developed networking technology to achieve a training realism not possible with legacy RF equipment and enable rapid phase-out of the obsolescent radio and telecommunications infrastructure. For example, after implementing the proposed SBIR, voice communications during a training exercise would now reflect real-world communications channel degradation through simulations of physical parameters, such as atmospheric disturbances, electronic jamming, and ship position parameters (e.g. beyond line-of-sight) relative to the training scenarios being presented to the trainees. In addition, implementation of the proposed SBIR would now permit both Joint and Coalition forces utilizing land-based training sites to train with U.S. Navy ships.

PHASE I: Research Tactical Voice requirements necessary to support current and emerging warfare strategies applicable to U.S. Navy, Joint, and Coalition forces. Develop Tactical Voice Training Metrics and Training Concept of Operations documents to define how the implemented SBIR proposal would, respectively, measure Tactical Voice training effectiveness, and present an overview of how the SBIR product would be utilized by the trainees.

PHASE II: Design the Virtual RF Tactical Communications system. Build and demonstrate a prototype version of the system.

PHASE III: Design, build, and demonstrate the production version of the Virtual RF Tactical Communications system. Upon successful demonstration, proceed with full-scale production and installation phase-in of the new system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to any training environment where team members are physically displaced, yet rely on voice-coordinated activities for mission success. Examples include civilian maritime and Coast Guard ship simulators, private sector environmental protection team training, and coordinated training for Homeland Defense and Emergency Preparedness agencies, and their contractors.

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KEYWORDS: Voice, communication, convergence, training, networking, collaboration

N04-168 TITLE: Reactive Tungsten Alloy For Inert Warheads

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: ACAT II: Gun Weapon Systems Technology, Naval Surface Fire Support project

OBJECTIVE: Develop a reactive tungsten alloy for use as the lethal mechanisms in the noses and payloads of supersonic and hypersonic kinetic energy munitions. The reactive enhancement will increase kinetic energy lethality while eliminating the safety logistics trail and expense associated with high-explosive warheads.

DESCRIPTION: Current research is focused on reactive materials with densities below 6 g/cc. Higher-density formulations (~ 17 g/cc) that may be possible with tungsten alloys are not being investigated even though they provide additional benefits over their low-density counterparts. High-density tungsten noses provide aerodynamic stability by biasing the center of gravity forward on the flight body and they provide excellent hard target penetration for direct strike munitions. The multiple functionality of this material would serve to ease the severe volume constraints of munitions. For payload dispense applications, higher-density pellets have better velocity preservation and penetration characteristics compared to their lower-density counterparts.

It is desired that the alloy developed under this initiative be energetic, but not compromise the safety of the projectile. The alloy should not reduce the projectile's Insensitive Munitions compliance, and should not increase a weapon's explosive rating. That is, if used in a system that is rated as a Division 1.4 (Class C) explosive, it should not increase it to a Division 1.3 (Class B) explosive.

PHASE I: Research and formulate chemical compositions for candidate reactive binders to hold tungsten particles in alloy. Evaluate their stability as a function of temperature to ensure that aero-thermal loading does not preclude their utility. Propose the most promising formulations for Phase II fabrication and testing.

PHASE II: Fabricate reactive tungsten alloys and test their mechanical properties for yield strength, hardness, elongation, and temperature stability. Provide samples to NSWCDD for gunfire testing to evaluate the reactive augmentation of kinetic energy upon target strike.

PHASE III: Transition into product improvements for guided munitions currently in development such as the Extended Range Guided Munition (ERGM) and the Long-range Land Attack Projectile (LRLAP), and to the Mk 182 KE-ET "Shotgun Projectile." Longer-range transition opportunities include the concept demonstration programs for the Extended Range Munition (ERM) and the electromagnetic gun's Hypersonic Exoatmospheric Round (HSER).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The underlying technology of this topic is the energetic reactions of tungsten, which has commercial potential in areas where tungsten and its compounds need to be formed and deposited. For example, tungsten disulfide has been proposed as an absorber material for thin-film solar cells (ref 2). Tungsten nitride and tungsten carbide films, produced by magnetron sputtering, are used a protective coatings for metals. Mixed metal oxide coatings of tungsten and a variety of other metals are used to produce building windows that change their light absorbance electrically (ref 3). Tungsten complexes are also used to initiate “ring-opening metathesis polymerization” of cyclic olefins. This process is used to create copolymers of polyacetylene and polyorganosilane, useful in creating stable, electrically conductive plastics. (ref 4). Use of an energetic tungsten-based reaction could improve these types of chemical processes, providing both the reaction material and its driving energy.

In addition to the underlying chemical applications, the military product of this research, penetrators made from reactive tungsten alloys, could be used in anti-terrorism efforts to remotely interrogate, disarm, disable, and or detonate bombs or suspect packages. They would be a safe replacement for high explosives to cut hard surfaces in operations such as mining, drilling, building demolitions, and salvage operations. Also, propelling reactive tungsten particles from high-pressure gas nozzles could be used to remove and or decontaminate hazardous materials and or hard surface coatings via the thermal and ablative nature of the reaction. The material can also be used in commercial small arms ammunition for law enforcement in specialized applications such as vehicle disabling rounds and less-than-lethal disarming of hostile criminals. Furthermore, the cost of such operations would be reduced via the elimination of hazardous high explosives.

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KEYWORDS: tungsten alloys, reactive materials, kinetic energy, lethality, penetrators, dispense, inert warhead

N04-169 TITLE: Pellet Dispense & Dispersion Mechanism For Inert Kinetic Energy Munitions

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: ACAT II: Gun Weapon Systems Technology program, Naval Surface Fire Support

OBJECTIVE: Develop a method to dispense and disperse pellets (any shape of preformed fragments such as cubes, dodecahedrons, buckshot, or other shapes that do not require a specific flight orientation) from kinetic energy munitions without the use of – or – with minimal use of high-explosive (HE) materials in expulsion charges and airframe perforation components. The efficient transfer of kinetic energy from projectile to pellet is key to ensuring maximum lethal effects. Reducing or eliminating HE from supersonic and hypersonic kinetic energy munitions reduces the safety logistics trail and expense as well as reduces the of hazards of unexploded ordnance.

DESCRIPTION: The lethality of kinetic energy munitions is dependent on the velocity of the projectile being efficiently transferred to the dispensed pellets and the pellets achieving the desired strike footprint. In addition to the forward velocity of the projectile, the pellet needs a lateral velocity component to achieve the required dispersion. This topic seeks an innovative approach to providing the dispensed pellets with sufficient lateral velocity to produce an effective footprint. Optimally, the system should be able to eject the payload at a velocity of approximately 200 ft/sec over a time interval. A less optimal approach would produce a range of velocities in an ejection event that is very short. Both these types of ejection produce coverage over the entire footprint, but a long ejection at consistent high velocity produces a more uniform pattern, because of interaction between the pellets and the projectile's shock wave.

It is desired that the dispense and dispersion mechanism qualify as a Division 1.3 (Class B) explosive, preferably as Division 1.4 (Class C), and optimally as non-explosive.

PHASE I: Research an efficient dispense and dispersion in which the airframe is opened and the pellets are directed towards the target with maximum velocity preservation while ensuring an even dispersion of pellets to achieve a uniform strike footprint. Since kinetic energy munitions require high velocities, ascertain whether aerodynamic heating of the airframe can be used to the advantage of the dispense and dispersion event. Propose the most promising method for Phase II fabrication and testing.

PHASE II: Fabricate and statically test the dispense and dispersion mechanism under the expected aerodynamic temperature. Provide samples to NSWCDD for follow-on gunfire testing under tactically representative conditions.

PHASE III: The mechanism will transition in the near term into product improvements for munitions currently in development such as the MK 182 KE-ET "shotgun projectile." In the longer term, it will transition into concept demonstration programs for the Autonomous Naval Support Round (ANSR) and the electromagnetic gun's Hypersonic Exoatmospheric Round (HSER).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Mechanisms to impart consistent high velocities to pellets have two applications in material fabrication:

1. An alternative to gas jets in the Rapid Solidification Process Tooling technique, where high-velocity molten metal droplets strike a ceramic or plastic pattern to produce precision tooling.

2. Shotpeening, a cold working process that creates a compressive stress layer at the surface of a metal part.

KEYWORDS: dispense, pellets, kinetic energy, lethality, inert, penetrators.

N04-170 TITLE: Glint Reduction in Staring Focal Plane Array Mid-Wave Thermal Imagers Employing Microscanning

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: Navy Directed Energy and Electric Weapons Program, PMS 405

OBJECTIVE Develop means to adapt mid-wave thermal imagers to perform in naval applications where the target must be acquired and tracked in the presence of a sea surface background producing sun glint.

DESCRIPTION: Thermal Imagers are utilized in a number of Navy day-night applications to supplement fire-control radars affected by multi-path effects for surface vessels and low-flying targets and to provide positive visual target identification. Thermal imagers operating in either the long-wave (8-12 micron) or in the mid-wave (3-5 micron) spectral region are available. Mid-wave imagers using the 3 to 5 micron spectral region provide some significant advantages to long-wave cameras. The technology for mid-wave focal array fabrication is more advanced than that for long-wave focal planes allowing production of high-resolution staring focal plane arrays at modest cost. Additionally, the LOWTRAN Atmospheric Transmission Model shows transmittance in the mid-wave spectral region is far superior to long-wave in the hot, humid maritime environment. Unfortunately, staring mid-wave thermal imaging cameras may be adversely affected by sun glint when operating in applications where the target must be imaged against a sea-surface background.. Depending on the sun angle and sea state, solar reflections may seriously degrade the capability of the thermal imager to provide target acquisition or precision tracking for fire-control applications involving conventional gun systems such as Phalanx or directed energy weapons. The purpose of this topic is to develop techniques to minimize the effects of glint in order to exploit fully the inherent advantages of mid-wave staring focal-plane array cameras for small target detection. Dithered scan imagers may provide an advantage in filtering in the optical domain to reduce the effects of IR Glint.

A combination of spectral, temporal, and polarization techniques to minimize the effects of glint may be employed. The glint response may be reduced to a minimum by tailoring the IR spectral band-pass and utilizing optimal polarizing filters. Innovative video processing should be developed to accommodate the remaining glint effect. Two operational modes are to be considered, target acquisition where some target latency is acceptable, and target tracking where a minimum frame rate of 30 Hertz is required. No latency beyond the single frame inherent in the RS=180 format can be tolerated. Microscanning requires the focal plane array to be processed multiple times in the 33 milliseconds field time with the LOS shifted by a fraction of a pixel for each sample. For imagers employing microscanning, timing must maintain the 30 hertz output required to meet the image latency requirement.

PHASE I: Analyze spatio-temporal microscanning techniques combined with optimal filtering to determine possible methods of target to clutter signal improvement. Expand analysis to incorporate improvement when combined with optimal spectral band-pass and polarizing filters. Develop adaptive local area processing using the database to develop algorithms to minimize the effects of glint in both the target acquisition mode and the target-tracking mode considering the latency requirements. Demonstrate improvement in performance from actual or simulated MWIR data of small objects in high glint backgrounds (spatial and intensity). Prepare a report of results obtained including the system design details of a prototype system to be used in subsequent phases.

PHASE II: Develop and deliver a modular prototype mid-wave thermal imager test bed based upon the techniques investigated in Phase I. Perform critical operational experiments with controls of the prototype in a shipboard environment under different sea-state/meteorological conditions. Demonstrate glint suppression for small target tracking and detection performance improvement. Submit a report summarizing the evaluation and including the design concept for a production imager addressing lessons learned in the operational evaluation.

PHASE III: Further develop the clutter suppression of this thermal imager by incorporating improvements resulting from the Phase II evaluation into a production design available for both military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that include security systems for port security and other Homeland Defense applications

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KEYWORDS: Mid-wave FLIR, adaptive video processing, GLINT, clutter, MWIR, nonlinear filtering, target acquisition, target tracking, ship defense, dither, microscanner, spectral band-pass, polarizing filters

N04-171 TITLE: Panoramically Scanned TV/FLIR Imaging Sensor with Target Motion Cueing

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: Navy Directed Energy and Electric Weapons Program, PMS 405

OBJECTIVE: Reduce operator workload and enhance situational awareness by panoramically scanning imaging sensors over the area of interest and employing automated video processing to identify potential targets.

DISCUSSION: Current methodology for employing Forward Looking Infra-red (FLIR) or television (TV) imaging sensors to search and acquire potential targets is work intensive and requires a continuous manipulation of complex controls by a highly trained operator. The operator must continuously scan the area of interest while critical sensor controls (FLIR gain and level, optical field-of-view (FOV) and focus, display contrast and intensity) are adjusted to obtain optimal performance. As time progresses, the operators become fatigued and their attention tends to wander, with a resulting decrease in the probability of timely detection of threat targets.

The intent of this topic is to develop new techniques that automate the manipulation of the sensor controls, scan the area of interest in an optimal pattern and employ state-of-the-art automatic target recognition (ATR) algorithms for pattern recognition of infra-red or TV video imagery. This investigation will incorporate cueing based on deterministic target motion and size change based on operator-defined lines of fire and threat axes. Multispectral (TV/LLTV/IR) comparison techniques will be investigated to improve target detection and reduction of false alarm rate.

PHASE I: Identify and define innovative techniques for automatically scanning TV/FLIR imaging sensors over a specified area of interest with automation of sensor controls to optimum values including changes to the FOV. Assess the feasibility of employing ATR techniques to alert the operator to potential threat targets. Demonstrate target motion cueing with multiple wavebands, individually and together. Both maritime environments for shipboard sensors and ground environments for perimeter defense should be considered.

PHASE II: Develop and deliver a prototype sensor suite integrating the techniques outlined /developed in Phase I. Conduct initial testing of the prototype of the automatic target recognition imaging system to demonstrate at sea operation and validate the techniques for scan automation and optimization for intruder detection.

PHASE III: Provide additional improvements that fully automate sensor system including workstation for operational evaluation. The Phase III effort will include integration and assessment of performance in both a maritime and land environment under varied environmental conditions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that include security systems, perimeter control and other Homeland Defense applications such as port security, border patrol, airport security, and freight operations.

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KEYWORDS: FLIR, TV, Automatic Target Detection, ATR, Auto Track, Panoramic scan, perimeter defense, multispectral , workload reduction, Homeland Security

N04-172 TITLE: Single-Point Turning Point of Polycrystalline Alumina Missile Domes

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a method for single-point turning of aluminum oxynitride and polycrystalline alumina to make ogive missile dome shapes with infrared-optical-quality surfaces.

DESCRIPTION: The fabrication of infrared-transparent polycrystalline alumina with a grain size of 0.5µm was reported in 2003[1-3]. This material has the same chemical composition as sapphire, similar physical properties, and similar optical properties in the 3-5µm infrared region. Aluminum oxynitride (ALON) is a commercially available, very hard, durable material with excellent properties for infrared-transmitting domes.

In the past, infrared domes have always been made with a hemispheric shape because this shape introduces minimal optical distortion. The DARPA Conformal Optics program that was completed in 2000 demonstrated methods to correct the distortions introduced by aerodynamic shapes such as an ogive. The ogive offers improved aerodynamic performance compared to a hemisphere. An ogive allows some combination of increased range, speed, and payload because of reduced drag. The ogive also offers improved rain and sand erosion resistance and a greater unvignetted field of view.

Good methods exist for grinding and polishing hemispheres made of very hard materials such as alumina and ALON. However, there are no good methods for shaping and polishing a tangent ogive made of such hard materials. For softer materials, such as magnesium fluoride (MgF_2), single-point diamond turning can produce ellipsoidal dome shapes. The purpose of this project is to demonstrate single-point turning alumina and ALON with a superhard, supertough point. If the surface cannot be taken to a final infrared-optical-quality finish by single-point turning, then a second method such as magnetorheological fluid finishing should be developed to produce the final polish.

PHASE I: Demonstrate a process for single-point turning of commercially available transparent ALON to make optical-quality flat disks and a hemispheric dome with a diameter base of 50 mm and a thickness of 2 mm. Measure surface roughness and wavefront distortion. The Government will measure infrared transmittance. It is expected that the contractor will purchase near-net-shape blanks for fabrication.

PHASE II: Demonstrate the optical fabrication of the following tangent ogive ALON domes: (1) subscale dome with a base diameter of 50 mm, a height of 50 mm, and a thickness of 2 mm; (2) full scale dome with a base diameter of 130 mm, a height of 195 mm, and a thickness of 2 mm. If the optical finish and optical figure obtained by single-point turning are not sufficient for 3-5µm imaging (as defined by the Government prior to the award of Phase II), then apply a second methods such as a magnetorheological finishing (or any other selected method) for the final finish. After methods have been developed for turning and finishing ALON, fabricate subscale and full-scale domes made of transparent polycrystalline alumina, if the near-net-shape blanks are commercially available.

PHASE III: Develop commercial capability for dome fabrication and processing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Optical quality polycrystalline alumina has commercial potential as the lamp element for high intensity automobile headlights.

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KEYWORDS: single-point turning, dome, missile dome, infrared dome, aluminum oxynitride, ALON, polycrystalline alumina, polishing, dome polishing, optical finishing

N04-173 TITLE: Polycrystalline Alumina Ogive Infrared Missile Domes

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Produce an optically polished, tangent ogive, infrared-transmitting missile dome made of polycrystalline alumina.

DESCRIPTION: The fabrication of infrared-transparent polycrystalline alumina with a grain size of 0.5 um was reported in 2003[1-3]. This material has the same chemical composition as sapphire and similar physical properties. Sapphire is the most durable, commercially available infrared missile dome material. Polycrystalline alumina should be ~1/2 as expensive as sapphire and can be cast into difficult shapes, such as an aerodynamic ogive. Polycrystalline alumina is potentially superior to the competing material, aluminum oxynitride (ALON). Polycrystalline alumina has a longer wavelength infrared transmission window that does ALON and approximately 3 times greater thermal shock resistance that ALON.

In the past, infrared missile domes have always been made with a hemispheric shape because this shape introduces minimal optical distortion. The DARPA Conformal Optics program that was completed in 2000 demonstrated methods to correct the distortions introduced by aerodynamic shapes such as an ogive. The ogive offers improved aerodynamic performance compared to a hemisphere. An ogive allows some combination of increased range, speed, and payload because of reduced drag. The ogive also offers improved rain and sand erosion resistance and a greater unvignetted field of view.

GOALS: By the end of Phase II, the contract shall (1) Demonstrate the ability to fabricate polycrystalline alumina with proper grain size for casting optical quality alumina domes. (2) Demonstrate near net-shape casting of infrared-transparent polycrystalline alumina in the form of tangent ogive whose approximate finished dimensions will be a base diameter of 130mm, a thickness of 2mm, and a height of 195mm. Exact dimensions may be modified during the course of the program. (3) Demonstrate methods to grind and polish the outside and inside of the dome to an optical quality finish. An opening will be left at the nose for future attachment of a durable nose tip. Specifications for the optical figure, surface quality, surface metrics, and nose-tip dimensions will be determined in consultation with the Government during the performance period of the contract.

PHASE I: Demonstrate the ability to fabricate polycrystalline alumina with proper grain size for casting optical quality alumina domes. Demonstrate a process for near-net-shape casting of a polycrystalline alumina ogive dome. The infrared transmittance of polished, flat witness samples shall be within 2% of that of sapphire in the 3-5 µm wavelength region. Cast a subscale tangent ogive with a base diameter of 50 mm, a height of 50 mm, and a thickness of at least 2 mm. Demonstrate a method for optical polishing and figuring of the outside of the ogive. By the end of Phase I, develop a plan for how the inside of an ogive can be optically polished.

PHASE II: Demonstrate the optical polishing of the inside of the subscale ogive fabricated in Phase I. Cast 3 full scale, near-net-shape, tangent ogive domes with a base diameter of 130 mm, a thickness of 2 mm, and a height of 195 mm. Develop methods for optical polishing of the outside and inside surfaces of the full scale dome and deliver 2 fully polished, full-scale domes by the end of the contract. Provide measures of optical figure and surface quality.

PHASE III: Demonstrate commercial production capability for casting and polishing of full scale alumina ogive domes.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Optical quality polycrystalline alumina has commercial potential as the lamp element for high intensity automobile headlights.

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KEYWORDS: dome, missile dome, infrared dome polycrystalline alumina, polishing, dome polishing, ceramics, ceramic fabrication

N04-174 TITLE: EF-18 Electronic Combat Automation

TECHNOLOGY AREAS: Battlespace, Weapons

ACQUISITION PROGRAM: ACAT-IV

OBJECTIVE: Enable advanced EW combat functions required on the EF-18 (Growler) to be performed in an unscripted fashion automatically by one individual rather than the current three individuals on the EA-6B (Prowler). The system would provide functionality equal to or better that the existing AN/TSQ-142 system on board the Prowler. This includes coordination with the ALQ-99 or its upgraded equivalent for jamming and HARM targeting functions. Final product is a SW/HW module that can be interfaced with an EF-18 simulator for systems evaluation and test.

Two key automation tasks are addressed by this proposal: 1) the detection, adjustment assignment and monitoring of the ALQ-99 and 2) the coordination of route and fuel planning, intelligence, and pre/post mission analysis. This is currently done via the Tactical EA-6B Mission Planning System (TEAMS) AN/TSQ-142 system with very significant ECMO input. The research will aim to develop an intelligent agent-based software module that aids the

ECMO is understanding the detected EOB parameters, monitors the jammers and their effectiveness on the mission objectives through reasoning and analysis. The agents will then coordinate with other (off-board) mission agents to ensure that plans in response to EW threats using the AN/TSQ-142 are consistent with team missions among the strike group. When inconsistencies are detected, the agents will work as a team to re-plan (leveraging joint interdependent routing technology developed at NRL) to ensure team missions/objectives are satisfied.

DESCRIPTION: Advances in intelligent, adaptive multi-agent systems as well as in processor speed, size, power, and capability now make it practical to massively off-load significant amounts of work associated with electronic combat previously performed by skilled human operators in the EA-6B. This proposal will advance agent teamwork and coordination to strike/support groups of EF-18's in achieving their missions in a complex physical, tactical, and electromagnetic environment with far less resources available (i.e., fewer ECMOs). The proposal draws from distributed artificial intelligence (DAI) of which intelligent agents are a part. Within DAI, the approach to problem solving is bottom-up as opposed to top down. Bottom-up problem solving involves coordination and communication between agents to address components of the problem, and coordination mechanisms to integrate solutions to address the larger problem.

The Belief-Desires-Intention (BDI) framework for teamwork and coordination will be applied to this problem in particular using the theory of joint intentions. This theory addresses mutual goals, joint persistent goals, and joint intentions between multiple cooperating agents to ensure the team achieves its goals. The theory hierarchically build up mutual goals between agents. From this, persistence (i.e., joint persistent goals) is included within mutual goals so that agents keep their goals until they are either satisfied, unachievable or when some other condition occurs. After agents enter into joint persistent goals, they can take actions to achieve those goals.

The agents will coordinate through the Control of Agent Based Systems (CoABS) grid (hereafter referred to as the "Grid"). The Grid was developed under the DARPA-CoABS program, and provides one of the most successful and widely used infrastructure to date for the large-scale integration of heterogeneous agent frameworks with object-based applications, and legacy systems. Based on Sun's JINI services, it includes a method-based application-programming interface to register and advertise capabilities, discover services based on those capabilities, and provides the necessary communication between services. Systems and components on the Grid can be added and upgraded without reconfiguration of the network. Failed or unavailable components are automatically purged from the registry and discovery of similar services and functionality is pursued. Program will be in three phases as noted below:

PHASE I: Develop the design for unscripted, agent-based Electronic Combat Decision Support System (ECDSS) for the back seater in the EF-18. System will need to know own aircraft equipment suite and particulars, surrounding electronic combat environment including blue support and red threat as well as the optimal methods of defeating the various red threats. System provides options to operator and then executes them.

PHASE II: Develop and test the ECDSS in an embedded software simulation environment which will allow full assessment of efficiency, accuracy, analysis of decisions made by the system, and provide for future upgrades and maintenance.

PHASE III: Integrate ECDSS into an EF-18 flight/mission simulator, prepare user-friendly instructional materials for use by back-seater; and provide mission assessment and results reports for system evaluation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Airborne aspects of homeland security including MANPAD protection systems on board commercial airliners and the FAA Free Flight proposal for commercial and private aircraft that abolishes air traffic control.

REFERENCES:
1. Sciortino, J.C., Jr., et al. (2003). "Multi-Agent System for Mission and Situational Awareness Management for Airborne Platforms", Proceedings of the 48th Joint EW Conference, 6-8 May 2003, Naval Post-Graduate School, Monterey, CA.

KEYWORDS: Electronic Warfare, intelligent agents, systems automation, artificial intelligence, adaptive processing, automated decision support, automated situational awareness and planning

N04-175 TITLE: Acoustic Surveillance Multi-Array Search Aid

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Bring together acoustic signal and information processing techniques (including passive automation and multi-array coherent processing) to enable geographically based acoustic operator search and contact classification.

DESCRIPTION: Integrated Undersea Surveillance System (IUSS) operators are expected to detect, localize, classify, and report acoustic contacts using means that rely on searching through large amounts of signal-processor-produced acoustic displays. Various automation techniques and operator aids can assist, however the final classification of contacts relies on an operator examination of first level acoustic displays. In large fields the total amount of acoustic display data to be searched easily exceeds the operator capacity to allow effective revisit times. Automation techniques that alert the operator to specific sectors or acoustic bands have shown promise. Acoustic displays that summarize contact data for a single array on a bearing-time plots, are also useful in guiding operators search through first-level acoustic displays. These techniques are useful for a very small number of acoustic arrays. For a large number of arrays a higher level of summarization is required to minimize the amount of first-level acoustic display data that the operator must examine. A natural high-level summarization approach is a geographic type display showing locations (with uncertainty) of acoustic contacts held by a composite field of arrays. With such a presentation the operator could select a specific contact on the display and then drill-down to examine the acoustic processor output on which the contact location is based. Automatic techniques which associate acoustic data from multiple arrays to form pre-classification acoustic contacts with position estimates are needed to support geographically based acoustic search

Therefore the primary thrust of the effort is to generate a data fusion approach which integrates outputs of available automation tools to produce contact summaries which include both a geometric state vector history and pointers to the automation tool outputs associated with specific contacts. Currently available automation tools which generate contact features to be input to the required data fusion engine include single-array narrow-band and broad-band trackers, target-type-specific feature detectors, and single-array range and depth measurement techniques. In cases where these automation tools produce outputs from multiple arrays for the same in-water unit, the fusion engine should produce a contact reflecting the integration of the multi-array data. Where automation outputs on a given contact are available from only one array, the engine should associate available features to produce a state-vector estimate, even if such estimate has larger uncertainties than would normally be expected for a multi-array contact.

PHASE I: Develop operational concept to automate geographic type display data required to alert the operator of the presence of acoustic energy that requires detailed acoustic processor data analysis for detection or classification.

PHASE II: Build and demonstrate an operational prototype of the multi-array automated search aid.

PHASE III: Transition the multi-array search aid into existing fixed and deployable sensor system programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Technology for the high level summarization of data that alerts an operator and assists in directing the operator to location requiring detailed investigation can be used in many applications where a limited number of operators are required to monitor a large amount of data.

KEYWORDS: Undersea; Search; Classification; Signal Processing; Automation; Geographic Display

N04-176 TITLE: Extended Range Optical Underwater Imaging

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: Office of Naval Intelligence (ONI-34)

OBJECTIVE: To develop a compact optical imaging system, deployable on a variety of platforms, including unmanned, underwater vehicles and capable of imaging through greater than 6 attenuation lengths of ocean water.

DESCRIPTION: Objects on the ocean floor that threaten Navy operations in coastal waters, such as bottom-mounted mines, and other objects of military interest are often obscured due to turbidity in the water column. Standard camera systems, operating passively with ambient sunlight or in combination with flood and strobe lights can typically image through 1-2 optical attenuation lengths (1/k; k = diffuse attenuation coefficient). In the 1990s, new imaging systems based on laser illumination, e.g., synchronous laser scan and imaging LIDAR approaches, have increased the imaging range to 4-5 attenuation lengths [1]. These systems are deployable on a variety of platforms, including 21" unmanned, underwater vehicles. However, light attenuation in very turbid water, such as associated with river plumes and resuspended bottom sediments, render even these systems ineffective due to the limited stand-off range necessary for generating high quality imagery and the associated decrease in survey rate. Therefore, the need remains to develop compact optical systems capable of imaging through greater ranges and deployable on a variety of Navy manned and unmanned platforms.

PHASE I: Investigate new and emerging optical sensors and components and, from these investigations, develop a preliminary system design that is compact, robust, relatively low power. Expected system performance should be evaluated using an appropriate system model and environmental parameters that are characteristic of ocean optical properties associated with the coastal benthic boundary layer [2]. The design study should include scenarios for integrating the imaging system with various platforms, including, but not limited to, a 12" autonomous, unmanned, underwater vehicle [3].

PHASE II: A prototype sensor will be developed and tested under controlled laboratory conditions. The system model, developed in Phase I, will be used to evaluate the performance of the prototype and to extend the observed performance to other operational scenarios as a means of assessing the validity of the system design. The laboratory experiments should clearly demonstrate the ability of the system to achieve the requested imaging range (6 attenuation lengths or more). The experimental design and model simulations must be constructed so as to understand the competing effects of light scatter and absorption on image quality and validate the concepts with respect to platform integration.

PHASE III: In this phase, the prototype will be subjected to a final demonstration, consisting of in-lab experiments with various targets and water quality. The potential for an at-sea demonstration should be considered, depending on the availability of a platform of convenience. A final report will be submitted to the cognizant program office, including detailed performance results from the various experiments, demonstrations, and simulations. A business plan will be developed that identifies potential user groups and estimated system cost.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential users of this technology exist within a variety of non-DOD government and private sectors including marine archeology, bathymetric charting, salvage, search and survey, and the oil industry.

REFERENCES:
1. Jaffe, J., K. D. Moore, J. McLean, and M. P. Strand. 2002. Underwater optical imaging: status and prospects. Oceanography. Vol. 14, No. 3, pp.64 – 75.

2. The Benthic Boundary Layer. 2001. Oxford University Press. 404 P.

3. Bluefin Robotics, http://www.bluefinrobotics.com/

KEYWORDS: Underwater imaging, laser, extended range, water optical attenuation, benthic boundary layer, system performance model

N04-177 TITLE: Development of Large bulk Silicon Carbide substrates from halogenated precursors

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To explore and develop a technology for growth of very long bulk SiC semiconductor boules of highest purity and structural perfection using (poly) chloro-hydrocarbon precursor gases.

DESCRIPTION: To date all SiC bulk crystals are grown by sublimation of highly impure corundum powder, which is made for the abrasives industry. This process suffers from changing source shape and surface area during growth which translates to highly impure and non uniform growth rates. As it is a limited source mass, the sublimation must stop when the source is close to exhaustion, and limited crystal boules to ~1 inch in length.

Because of the extremely high temperatures required to sublime SiC (~2,400C) the only container materials possible are made from graphite, which is very prone to shedding particulates, which then get on the growing crystal surface and generate micropipes and other electronically deleterious defects.

Also the very large temperature excursion to room temperature, after growth, builds in severe stresses which translates to large dislocation densities and the initiation of stacking faults, which at present degrade bipolar SiC devices almost immediately when they are turned on.

PHASE I: Develop a strategy and define prototype equipment for the growth of bulk SiC, from highly purified halogenated hydrocarbons and silane gas sources that effectively are inexhaustible. Investigate bulk growth temperature reduction (> 600C) by use of hologenated precursors. Investigate the purity and growth duration possible with halo-precursor growth.

PHASE II: Prototype equipment and demonstrate reproducible growth of >3 inch long SiC crystals of 3 inch, or greater diameter, with low impurity density and at lower temperatures and at faster growth rates than allowed by conventional HPV (sublimation) growth. Slice, polish and characterize significant number of 3 inch diameter substrates from grown boules and deliver to the government for testing/characterization. Resistivity of undoped grown crystals should if possible be > 1e6 ohm cm.

PHASE III: Produce commercial scale > 3inch diameter SiC with reduced impurity dislocation and micropipe densities. The latter should be below 5 per cm square.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is already a strong commercial market for SiC but the quality is sufficient only for LEDs, and not for microwave or high voltage switching.

REFERENCES:
1. J. D. Parsons, and G. B. Kruaval, Electrochem. Soc. J. 1412, 771, (1994)

2. M. S. Saidov,. K. A. Shamuratov, and M. A. Kadyrov, J. Crystal Growth, 87, 519 (1988)

KEYWORDS: SiC bulk growth, SiC epitaxy, halide precursor, high purity, low stress bulk SiC growth

N04-178 TITLE: Image-Based Obstacle Avoidance

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace, Weapons

OBJECTIVE: Develop 3D image-based proximity and flow sensing systems that can enable autonomous air vehicles to avoid obstacles and features in complex environments.

DESCRIPTION: One of the key challenges facing the US military is the inability to use autonomous platforms in complex, 3D environments where non-line-of-sight operations and collision avoidance are paramount concerns. A successful system must be capable of detecting the presence of an obstruction, understanding the probable extent of the obstruction, calculating a maneuver response and implementing the results in an autonomous flight control system. Timelines for these events in urban environments is measured in the tens of milliseconds. Current active-matrix digital imaging sensors have the capability to compute motion and proximity sensing within the required time parameters. Simple motion sensing techniques, however, are not adequate for operations in unconstrained environments. The intent of this topic is to identify methods for coupling cognitive functionality with these rapid response sensors for an overall system capability that can be integrated on-board a small, light-weight air vehicle.

PHASE I: Using novel systems engineering approaches, determine the feasibility to quickly and accurately sense and understand objects and features in a complex environment. Establish probabilities of collision for autonomous air vehicles maneuvering in a range of environments from dense urban to urban sprawl. Establish measurements and constraint models for integration with existing digital imaging sensors.

PHASE II: Develop a cognitive, digital imaging sensor prototype to establish relationships between range of motion, obstacle proximity, feature complexity, and other factors affecting the performance of the overall system. Create a robust model for measuring probabilistic performance for a range of environmental conditions. Demonstrate prototype system in airborne vehicle against typical urban scale features.

PHASE III: Develop the prototype for integration on a small-scale autonomous air vehicle. Evaluate performance in a field demonstration in operational setting. Develop complete system and process specifications for specific DoD platform applications and transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed novel technology would have broad civilian impact for intelligent collision avoidance systems, including automobiles, boats, and aircraft.

KEYWORDS: Active-Matrix, obstacle, avoidance, 3-D, imaging, autonomous

N04-179 TITLE: Radio Frequency Identification (RFID) Technology Cost Reduction

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics, Weapons

OBJECTIVE: The application of radio frequency technology is a Combatant Commander's Requirement. This requirement applies to much of the supply chain process within the Naval Force structure – prepositioned material and equipment, ammunition, unit equipment and sustainment material. There is currently a system available to the Department of Defense for providing RFID capability. This system contains an extensive reader infrastructure that operates with a proprietary communications protocol. Naval Forces implementing RFID technology must purchase RFID tags compatible with that infrastructure protocol. This protocol limitation along with other industry-wide factors such as antenna design, battery design, infrastructure (tags, readers, software and communication links) design, international frequency approval, manufacturing processes and lack of or inadequate business case analyses have contribute to a prohibitive cost in purchasing and maintaining RFID technology for fleet forces. The objective of this SBIR is to perform innovate research in one or more of these areas for an overall reduction in the life cycle cost of using RFID technology.

DESCRIPTION: This project seeks to perform research in any of the areas listed above. Focus on specific technology innovation may include but is not limited to tag-to-tag networking, manufacturing sciences, dual-frequency tags, dual-frequency readers, combination tags (i.e. passive/active, short/long range) and open communications protocols. It should be clearly described how the chosen technical innovation can affect the life-cycle cost of RFID technology and how that technology would be suitable for use in a Naval operation and joint forces environment. This effort will be conducted according to the following phases:

PHASE I: Conduct research and development in a selected technology area. Provide analysis showing this technology will affect the cost of the use.

PHASE II: Develop a prototype for testing. Develop testing metrics. Conduct bench testing in a relevant environment, achieving a readiness level of TRL6. Assess results and modify design as applicable. Document the findings.

PHASE III: Prepare user-friendly packages for use by civilian and military environments to enhance operations and reduce system costs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed under this SBIR could be easily adapted by the commercial sector to enhance operations and reduce system costs.

REFERENCES:
1. Draft Statement of Combatant Command Radio Frequency Identification (RFID) Requirements, 8 August 2003.

KEYWORDS: RFID; radio frequency identification; readers: tags; supply chain; communications protocol; in-transit visibility; total asset visibility

N04-180 TITLE: <u>Nested Radio Frequency Identification (RFID) Tags to Improve Supply Chain Management</u>

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: The need exists to integrate passive Radio Frequency (RF) asset tag technology with Active tags. While active and passive tags have been shown to solve differing supply chain management problems (Passive-inventory simplification; receipt/issue automation: Active-embarkation/debarkation asset visibility, in-transit asset visibility; environmental monitoring/reporting). While each technology is used effectively to solve the different problems, an integrated solution does not exist which can meld the technology and give a more robust solution. A desired capability would allow the active device to automatically collect asset information from individual passive tags and either report the collected data or store the information on board the active device.

DESCRIPTION: A notional concept is envisioned whereby passive tags are affixed to individual items, cases and/or pallets. At the next high level of packing (pallet or container), an active device interrogates the individual passive devices. The active tag maybe used to aggregate the contents and report as the pallet or container transits various active interrogators at chokepoints, portals, points of embarkation/debarkation etc. The automation of the process to prepare the pallet/container manifest data will;

1. Reduce the labor required to manually build a manifest for pallets and containers

2. Reduce the errors introduced by manual processes and enhance the accuracy of manifests

3. Make it more difficult to place un-authorized/unwanted material in pallets/containers

4. Allow for near real-time updates to the Global Transportation Network (GTN) of consolidations and active device locations. This would include any last minute changes required during consolidation/shipping process.

5. Enable the automatic reporting of depletion of supplies as they are removed for use from pallets/containers

PHASE I: Determine if “off-the-shelf” and near-term development of passive tag technology that would be suitable for use in the scenarios described above. The active tags will be battery powered, passive tags requiring relatively low RF field strength for interrogate/read cycles will be required. Also, any innovate passive tag technologies that would reduce the complexity, lengthen battery life of the active tag should be evaluated/identified. Active tag technology should be investigated that will enable the integration of the passive/active combinations. With this baseline and the input of a government involved selection panel, pursue a nesting architecture as the innovative development focus.

As an adjunct to the technology required, analysis of the following military supply chain scenarios should be conducted to determine potential value added of the enhanced technology.

1. Naval expeditionary forces undergo unit moves requiring the pack up and transit of large amount of material to implement initial capability and provide for limited sustainment. Analysis of the chain of events from pack-up/move, transit to POE, transit to AO, debarkation and transit to frontlines shall be analyzed to determine the positive impact the envisioned technology may have.

2. Naval vessels at sea regularly perform underway replenishment. This involves the assemblage of materials into shipment units (usually tri-walls) on shore, side, at-sea transfers via airlift, helicopter, or ship, the “break down” of or transshipment the shipment units, and receipt processing and the stowage of the materials by the receiving ship. An analysis similar to that above to identify the positive quantitative benefits of the proposed technology shall be performed. This positive control over materiel movement will become more critical as DoD attempts to establish a joint Sea-Base capability.

3. Key to the deployment and employment of the present MPF and Future MPF to joint operations will be the integration of Active/Passive RFID Tags for sustainment held within containers (Twenty Foot Equivalents - TEUs)--we must provide a seamless view of TAV and ITV especially when Service and joint stocks are constantly being removed/added to a container—afloat & ashore. This project to better enable asset visibility would support both near and mid-term MPF operations.

PHASE II: Based on the results of the Phase I, laboratory experiments would be conducted to determine the feasibility of the proposed technology. Of special consideration will be the accuracy, read rates and ranges of the passive/active tag couple taking into account the unique environmental and safety restrictions aboard naval ships. Also any technology developments required should be done to the level appropriate to demonstrate proposed solutions in laboratory environment. The analyses of Phase I maybe required to be updated with new scenarios as transformational concepts such as Ship to Objective Maneuver in an Enhanced Sea Basing environment are refined. Deliver prototypes (250 passive and 5 active tags) responsive in the developed nested architecture for further evaluation.

PHASE III: Market the technology to interested military commercial vendors and other agencies that have similar interests in developing enhanced methods for supply chain management.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Numerous commercial companies are interested in overcoming the costs associated with active tags technology and the limitations of read ranges and rates for passive tags. The integration of the two will enable more efficient and accurate invoicing, warehousing and transportation of consumer products from the manufacturer to the consumer.

KEYWORDS: RFID, Passive Tags, Active Tags, Asset Visibility, Supply Chain Management, AIT

N04-181 TITLE: <u>Microminiature Sensor System for FORCENet</u>

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes, Sensors, Electronics, Battlespace

OBJECTIVE: Develop microminiature RF sensor systems to serve as front-end sensors in the Navy’s FORCENet future sensing and C2 network.

DESCRIPTION: FORCENet calls for a network of sensors feeding near-real-time data to the warfighter. This proposal investigates the limits of RF sensor miniaturization, which will serve FORCENet in several ways. First, current sensor size makes finding and disabling such sensor networks simple for the enemy. Miniaturizing systems would make detection more difficult, thus improving OPSEC of the sensor systems and their networks. Secondly, size and space reductions anticipated in a variety of Naval fighting and sensor platforms will force concomitant reductions in payload size and weight. Thirdly, size reduction (and associated second-order reductions in power and cooling requirements) will enable placing RF sensors on platforms not currently feasible, such as small and micro-sized unmanned vehicles. Finally, microminiaturization opens the potential for great cost savings in both manufacturing and logistics.

PHASE I: Explore existing and developmental technology to establish both the theoretical and near-to-mid-term practical limits of miniaturization for radio frequency (RF) sensors. Report findings and provide an initial specification for a sensor to be prototyped under a Phase II effort. The topic submitter anticipates, but does not require, that the principal thrust of investigation will be miniaturizing antenna elements with both materials science and electronic approaches. This report will bound the scope of Phase II's research to a realistic and achievable degree of miniaturization.

An example specification:
"The sensor package shall include an RF sensor from antenna to data out, onboard signal recognition and analysis, communications both for C2 and data reporting, and essential support functions such as power, cooling, and environmental hardening.
The sensor package's analytic capability shall accept tasking for frequency range covered, signal strength threshold, and the nature of analysis desired.
- If tasked for new energy alarms, it shall scan in frequency and provide such alarms based upon defined signal thresholds.
- If tasked for spectrum relay, it shall digitize and relay a portion of the spectrum for either a set duration or until energy meeting a threshold value is no longer present.
Objective performance goals are
- coverage 500kHz to 18GHz with
    - minimum instantaneous bandwidth of the lesser of 20MHz or 7% of center frequency
    - at least one sub-band tuner available for 800MHz and below
    - at least three sub-band tuners available from 800MHZ to 5.5GHz, and
    - at least one sub-band tuner available from 5.5GHz to 18GHz
    - signal quantization with minimum 85dB dynamic range and 12bit resolution
- volume less than 24 cubic inches,
- weight less than 12 ounces,
- waterproof in sea or fresh water to a depth of 15 feet,
- survivable in sea or fresh water or in salt air per notional MILSPEC reference for 30 days
- operable from 0º to 155ºF and survivable from -20º to 200ºF
- certified for flight per notional NAVAIR reference, and
- operating 144hr in standby deployed and awaiting tasking, 48hr RF reception and processing, and 30min uplinking collected data at least 5 miles at 25kbps or better.
Threshold performance goals are
- coverage 500kHz to 18GHz with
    - minimum instantaneous bandwidth of the lesser of 4MHz or 4% of center frequency,
    - at least one sub-band tuner available for 800MHz and below, and
    - at least two sub-band tuners available from 800MHZ to 18GHz
    - signal quantization with minimum 75dB dynamic range and 8bit resolution
- volume less than 100 cubic inches,
- weight less than 40 ounces,
- waterproof submerged in sea or fresh water,
- survivable in sea or fresh water or in salt air per notional MILSPEC reference for 10 days
- operable from 40º to 100ºF and survivable from 0º to 155ºF, and
- operating times of 96hr in standby deployed and awaiting tasking, 24hr RF reception and processing, and 20min uplinking collected data at least 3 miles at 10kbps or better."

PHASE II: Based upon the specification developed in Phase I, design, develop and deliver a prototype system. Identify any capability limitations or potential enhancements stemming from the degree of miniaturization achieved.

PHASE II OPTION: Field a prototype microminiature RF sensor within FORCENet.

PHASE III: Develop an operational network of microminiaturized sensors embedded into FORCENet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Microminiaturized sensors (or microminiaturized network interfaces, which may be considered the communications portion of a sensor package) will allow network-aware and network-enabled features to be embedded into ever-shrinking portable devices. Beyond consumer goods, potential applications include:
- self-locating, self-policing cargo containers that detect and report improper cargoes or environmental conditions out of limits
- self-tracking parcels
- locator tokens for children or other persons such as Alzheimer's victims or parolees requiring tracking.

REFERENCES:
1. Los Angeles Times, "Five Reasons to Hope", 9 May 2003

2. Smalltimes.com, "As Privacy vs. Security Debate Heats Up, NSF primes Sensor Pump", 25 April 2003

3. DARPA BAA 03-Q-4110 "Advanced Beacons".

KEYWORDS: nanotechnology, sensors, miniaturization, microminiaturization, electromagnetics, RF, FORCENet, unmanned vehicles, payload, antennas, electrically large

N04-182 TITLE: IP Performance Enhancement Devices

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT III, ADNS

OBJECTIVE: Investigate, evaluate, and test Internet Protocol (IP) Performance Enhancement Devices (PEDs) to improve IP performance on the Navy RF Wide Area Network (WAN) through noisy, narrow and medium bandwidth satellite communications (SATCOM) (long delay) and Line-Of-Sight (LOS) (noisy, intermittent) links with highly constrained bandwidth.

DESCRIPTION: Naval communications systems can be made to support higher IP throughputs by incorporating Performance Enhancement Protocols (PEPs) such as traffic shaping, quality of service, caching, compression, acceleration, proxies, channel access protocols, and forward error correction (FEC) techniques. Performance Enhancement Devices (PEDs), which facilitate these PEPs, promise great capabilities in dynamic allocation, improved performance, and better management of satellite and LOS bandwidth available on a Navy ship.

However, PED capabilities, if inappropriately coupled together, could significantly increase complexity and degrade overall system performance. Furthermore, in order to achieve the efficiency goals in mind, these devices may routinely require operator attention to optimize efficiency under changing operations. When compared to current shipboard communication equipment, which rarely requires operator interaction, these new devices could result in a workload that a ship's workforce may not be prepared to support.

This solicitation seeks a standard Navy approach to capture the improvement in performance PEDs can offer without significantly increasing complexity or workload to ships force. Respondents to this SBIR should address one or more of the following categories:

•PEDs which support satellite links with long delay times
•PEDs which support noisy and intermittent Links
•PEDs which support periodic disruptions in connectivity

•PEDs which support over-subscribed satellite links
•Combinations of the above

The following technical parameters should be considered for the TCP PEPs;

Management — There should be a secure method of management and monitoring, via a separate management port (PHY) or an encrypted in-line method (SSL, SNMPv3). The PED should fail to a passive Ethernet bridge when shutdown or when it crashes -- makes a virtual wire.

Protocol support — The PEP should support TCP, UDP and Multicast (PIM). IPv6 is not supported by any current PEP, so the PEP needs to support protocol pass-through for IPv4 and IPv6 traffic that cannot or will not utilize the PEP. An all-or-nothing solution is not feasible or practical.

Rate Pacing (shaping) — Meter out large bursts of TCP traffic at a rate not to exceed the configured maximum transmission rate of the wireless or satellite channel. This prevents the channel from becoming congested and reduces the TCP saw tooth, which occurs.

Selective Negative Acknowledgments (SNACKs) — SNACKs are used by SCPS to identify specific lost or damaged packets and requests retransmission of those packets. This provides for quicker recovery and better bandwidth utilization in these environments. The PEP proxies TCP to SCP in the SATCOM WAN and eliminates ACKs.

Quick Start — makes full and immediate use of the allocated bandwidth, eliminating the inefficiencies of the TCP slow-start algorithm. The PEP should also be engineered to reduce TCP global re-sync.

Window Scaling — support for large TCP frames, megabytes to hundreds of megabytes. TCP is limited to 64byte windows and should be tunable on a flow-basis (minimum) over the WAN.

Transparent — all of the aforementioned functions should appear transparent to the end hosts.

Speed — should support 10mb half-duplex Ethernet (802.3) at a minimum.

Placement — LAN side should be the enclave. WAN side should be the WAN (ADNS) router.

Bit-error Rate (BER) — should support an adaptive Reed-Solomon algorithm. As the link error rate increases, the algorithm pad grows in size to adapt to the change in link conditions. Error rate is a critical issue with TCP.

Interoperability — should support TCP peering. PEP can proxy to TCP on both sides of the network (from LAN and from SATCOM), eliminating the need for a device at both ends of the network.

Investigation should include whether the PED is required on both sides of the link in order to maintain connectivity. A PED may consist of several layers of abstraction in the optimum configuration of the system elements. The first layer of abstraction would offer only those capabilities of device operation consistent with the simplest operation. The next layers would offer greater capabilities at the price of increased complexity. The last layer of complexity would offer full capabilities of improved performance. These layers should be designed so that an operator should be able to add layers as necessary to improve performance. Furthermore, the devices should be automated and included as part of the system control.

The Navy seeks a recommendation for optimum combinations of PEDs, including recommendations for combinations which should be avoided.

Once the optimum combination has been determined it is desired, where possible, that PEDs and/or combinations of PEDs should be a software upgrade to an existing component such as the router, Crypto or Modem. Stand alone boxes (Processors) should be avoided where possible or at least reduced to the least number practical. Preferred PED protocols are standards based, open, scaleable, modular, portable, software based compatible with standard systems. Proprietary solutions using fixed hardware, firmware are not preferred. PEDs which integrate easily into the RF

WAN management and Control System (part of the JTRS Cluster III SPEC) are preferred over PEDs with stand alone controllers.

Respondents which present the best open architecture approach which are compliant with SCA standards and develop an open standard management function which controls combinations of PED efficiently consistent and integratible with SNMS radio room automation controllers will receive the highest consideration.

PHASE I: Perform trade study to determine the best PED candidates to address Navy requirements. Through simulation or laboratory demonstration, test various PED combinations and select the best candidate solution(s) to be further analyzed in Phase II. Perform analysis or simulation to determine the potential capabilities of identified PED solutions.

PHASE II: Implement prototype demonstration of PED solutions in a manner suitable for laboratory testing.

PHASE III: Integrate the PED prototype combinations into the ADNS and JTRS DCRM (or surrogate) architecture and perform end to end testing in the Fleet PMW 179 Transport Test and Integration Complex (TTIC). Determine optimum combination of integrated PED for the proposed Navy Architecture. Build, test, and install systems onto Naval Surface Ships for an at-sea demonstration. After successful results recommend incorporation into JTRS/ADNS/DCRM as appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Would be useful for any industry desiring to operate these devices with personnel of less expertise.

REFERENCES:
1. http://www.packeteer.com/

2. http://www.cisco.com/

3. http://www.scps.org/ Space Communications Protocol Standards

4. http://www.ietf.org/ Internet Engineering Task Force

5. http://www.iso.ch/ International Organization for Standardization

6. http://www-jta.itsi.disa.mil/ Defense Information Systems Agency, Joint Technical Architecture

7. ISO Standard 15893:2000 Space data and information transfer systems – Protocol specification for space communications transport protocol

8. MIL-STD-2045-44000 Department of Defense Interface Standard, Transport Protocol for High-Stress, Resource-Constrained Environments

KEYWORDS: PED; IP; RF; SATCOM; LOS; JTRS